Journal
of the
British Interplanetary Society

Vol. 8 No. 6 **XXXI** **November, 1949**

CONVERSAZIONE

A report of the meeting of the British Interplanetary Society held in London, on October 1, 1949.

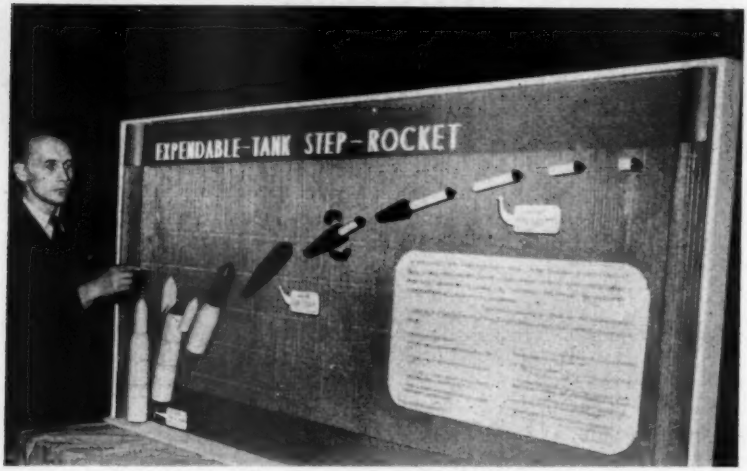
Although a new departure for the B.I.S., the Conversazione was a great success. Much valuable experience was gained which will benefit the Society in future functions of this character. Until now we have played a subsidiary role in those exhibitions with which we have been connected. Members will probably remember that the most notable of these, since the beginning of the last war, were the Birkbeck College Conversazione of 1945 and the Plymouth Model Engineering Exhibition in 1946.

The prime object of the present exhibition, to stimulate interest and discussion on the numerous facets of Astronautics, was fulfilled to a pleasing extent. So much so, that at one point in the afternoon a period of ten minutes was needed for a news agency camera-man to take a group photograph of our Chairman, Secretary and Mr. Clarke. The reason—a running fire of questions and discussion by visitors and members!

Small discussion groups formed here and there in the hall, each containing as a nucleus some member of the Council or one of the Fellows, who were stationed amongst the exhibits for just that reason.

Moving around the Exhibition Hall, one could hear dissertations, helped by the fine drawings and photographs on the future trend of rocket design, on the reason why an injector works better here than there, and at any moment Exhibition Officials were liable to be pinned down and asked such things as—"What *is* Specific Impulse?" On the Astronomical side discussions ranging from the airy proposition of entirely new cosmogonies to the probable conditions on the surface of Venus, formed a lively background to the viewing of remarkable photographs and interesting exhibits.

Somehow, the gathering broke down that atmosphere of reserve which habitually cloaks convention and inhibits the mention in a serious vein, of such things as the physical requirements of a man on the surface of the Moon, or the possibility, a relatively short time ahead, of man ceasing to be confined to one rather insignificant planet. Members and visitors had the time, so lacking at lectures, of really formulating their questions and points. Indeed, so well was this attitude of reserve carried away, that our youngest visitor, aged 9½, looked into the eyepieces of the Lunar model of Mare Imbrium very critically, paused a suitable space of time, and remarked to the attending Fellow, "Not bad," in a way which suggested that *much* could be done in the way of improvement.



Mr. Gatland with his expendable-tank step-rocket exhibit.

Mr. J. H. Lowden, Chief Designer for the Fairey-Clyde Aviation Company, discusses the construction of rockets which have already been used, with Mr. P. W. C. Monk, a member who works at the R.A.E., Farnborough. Mr. Lowden leaves Britain shortly on a three-year contract to work on guided missiles in Australia.

Our colleague was further shattered by the information that our aspirant had now given up the study of petrol engines and was henceforth devoting his time and talent to the study of atomic power. Scattered learned references to this form of energy were followed by a suggestion that any models "left over" after the Exhibition could be sent along to his home address. He added that actually it was possible for him to take some of them *now*, if that was convenient. This promising young astronaut had already submitted drawings of "spaceships" to the B.I.S. for comment. We shall no doubt hear more from him.

This and other situations of perhaps a more serious character were dealt with during the afternoon. Questions which baffled one official were rapidly "shunted" to the right specialist, and no instance came to the writer's ears of a disappointed questioner!

A pleasant note was struck during the proceedings by the announcement that Tea would be served free of charge to members and visitors alike, in the School of Arts Restaurant—and discussion continued during the meal.

After the Tea, and in addition to the "static" exhibits, two short astronomical films were shown, with commentary by Michael Ovenden, followed by a few slides illustrating the development of the rocket from the Chinese Fire Arrow used in the defence of the city of Kaifeng in 1232, to Oberth's conception of a future space rocket used in the film "Girl in the Moon," made by Fritz Lang in Germany some 20 years ago. The slides were presented by our Chairman, Val Cleaver, who provided them with an interesting historical continuity.

Every exhibit in the Conversazione is worthy of mention, but such is impossible in this account. However, a complete list is appended for reference, and a glance through reveals the very wide field of subject matter and science covered.

Excepting a small section, the whole emphasis was on current research.

Numerically, photographs and drawings were by far in ascendance, lining the walls at eye-level and placed on the tables below. They were all of exceptional quality and although the group-labelling could have been more distinct they were laid or presented in sets which illustrated, in a most effective way, trends and programmes of research.

The Interplanetary Section

For instance, there was an Interplanetary Section which was a veritable feast of new and provocative designs and ideas, including some excellent drawings, both pictorial and sectional, by Ralph Smith. His subjects included landings on the Lunar surface, Rocket-launching from a floating platform, the Orbital Space Station, and the old B.I.S. Spaceship design. This last drawing, together with the designs of the Man-carrying Rocket and the models of the Expendable Tank Step Rocket (to be mentioned later) illustrated the trend of thought of B.I.S. members in the field of spaceship design; whilst excellent drawings of a type of space-suit served to show the progress in the field of environmental adaptation. This design will be the subject of a paper to be read at the coming November meeting. From the sublime to the humorous was a collection of cartoons which have appeared in various leading newspapers from time to time, having been inspired by meetings and lectures of the Society—not

John Dawson, a nine-year-old rocket designer, of Holloway, London, has a serious technical discussion with Mr. R. A. Smith, of the Government Rocket Research Station at Westcott, who is responsible for the designs of the man-carrying spaceship exhibited on the right. John sent some of his designs to the Chairman of the Society, who thought either that some person with technical knowledge was pulling his leg or that they were genuinely the work of a young prodigy. Invited to the Conversazione, John explained his own design to Mr. Smith, who pointed out that the young rocket expert was sound in the principles of design, but running into trouble when it came to providing the power source—the biggest snag which the Society itself has encountered. John has been studying the question full-time for two years in London's public libraries and has also designed apparatus for measuring cosmic rays. . . .

the least, those which appeared after Dr. Stapledon's lecture in which he described Interplanetary Man!

Just to show the wide gulf which lies between the film producers' conception of a space-vessel and the, shall we say, "down to earth" designs, dictated by physical needs, a series of four photographs from the film "Spaceship I Departs," were exhibited. One was hard pressed to visualize such a vessel making Little Wapping in safety, let alone the bleak craters over which it was depicted in one of the photographs. Astronautical computation was represented by a series of spaceship orbits for different voyages.

The Astronomical Section

In the lower portion of the Hall the Astronomical and Lunar Section of the Exhibition contained a most impressive array of photographs and drawings. The majority was concerned with the Moon, and the composite photographs from Lick Observatory were the most outstanding of these. Excellent work by Eric Burgess produced a fine selection of Lunar photographs of many portions of the surface, serving to show at the same time the fine quality of work possible with an ordinary camera and a telescope of modest aperture—in the hands of a determined observer. A globe of Mars and photographs of Saturn added interest to the collection. There were many drawings of Lunar features by members of the Lunar Section of the B.A.A., and perhaps one of the most notable of these was the drawing in colour of the Crater Plato by Mr. L. F. Ball. A section of the 100-in. reproduction of the B.A.A. Lunar Director's map of the Moon gave a fine example of large-scale map work and this was contrasted by a map of the Moon some 18 in. diameter, which is sold for the very reasonable sum of 1s. 8d. by Geo. Phillips & Son., Ltd., of Fleet Street, London.

Research and Military Rockets

Illustrating the vast expansion of military and research rocket design since the beginning of the last World War, was a huge collection of photographs and drawings covering British, American and German research, past and present. All the now familiar German war rockets were depicted, further illustrated in many cases by new data. Perhaps the two most interesting to B.I.S. members were the Rheinbote and our old "friend," the V2. The wealth of material describing current American work in the field, was typical of the information organization of that country. It covered rocket aircraft such as the Bell X–1 and the rocket-assisted Boeing XB 47, the many and varied research rockets of the U.S. Army and Navy, including the "Bat," Aerobee, W.A.C. Corporal, experimental V2's and the Viking (née Neptune). Most impressive were the high-altitude composites, showing the curve of the Earth's limb and, in one case, covering a stretch of territory over 2,000 miles in extent. Many of these have appeared in various periodicals from time to time and have never failed to cause amazement. It recalls the epic photograph taken from the Explorer II, Stratosphere Balloon, in 1936. This showed, for the first time, a distinct curvature to the limb of the Earth. A copy of this was also on view. There were four photographs showing a mechanical calculating machine of awe-inspiring proportions—which emphasized, if emphasis were needed, the incredible

Two visitors, Mr. S. Lane and Miss W. Linch, inspect an artist's representation of a rocket being launched on its return journey from the Moon. Mr. Lane has been a member of the Society for a year, but his profession is advertising.

Mr. B. R. A. Shaw and Miss F. Hunter were suitably impressed by a representation of the "Appearance of typical spaceship at rest on the Moon."

complexity of present-day ballistics. This mathematical colossus fills a huge room at Dahlgreen, Virginia, 50 ft. square, and weights 25 tons. Initially it was designed for the computations arising from rocket research.

In contrast to this prolific array, British rocket development was represented by a very small number of photographs and drawings. The chief of these exhibits described the de Havilland Sprite A.T.O. unit, which has had a team of B.I.S. members working on its development, and the Vickers' Transonic rocket. This last was shown as a cut-away drawing in colour and was one of a series made available by the courtesy of the editor of *Aeronautics*; others illustrated fuel feed systems, injection and cooling systems, and the like. Of particular interest was a cut-away view of a V2 adapted for high altitude research, with its nose packed with such equipment as multichannel telemetering sets, cosmic and ultraviolet-ray testing equipment, sampling apparatus and cameras, grouped in one of the most compact recording and transmitting units yet devised.

Of similar character were the 14 cards illustrating various phases of Rocket Development. Initially these were prepared for, and exhibited in the "Designs of the Future" section of the Britain Can Make It Exhibition.

The History of Astronautics

The History of Astronautics was traced, in another section of the Conversazione, in caricature, diagram and photography. Caricature was represented by a copy by one of the members of Golightly's "Aerial Steam Horse" and with the diagrams of the first proposed Steam Reaction Car and Battey's Rocket Airship, revived memories of the first primers in reaction propulsion, so new so short a time ago. The Kaifeng Rocket Arrow of 1232, mentioned previously, headed the line of development to be followed nearly 600 years later by the Congreve Military Rockets and in 1855 with the Two-Step Life Line Rocket. These relatively inefficient forerunners were shown to give way to the liquid-fuel types represented by that of Dr. Winkler in 1932. Future ideas were, in this series of pictures, identified with Oberth's "Girl in the Moon" Spaceship.

A Remarkable Collection of Stamps

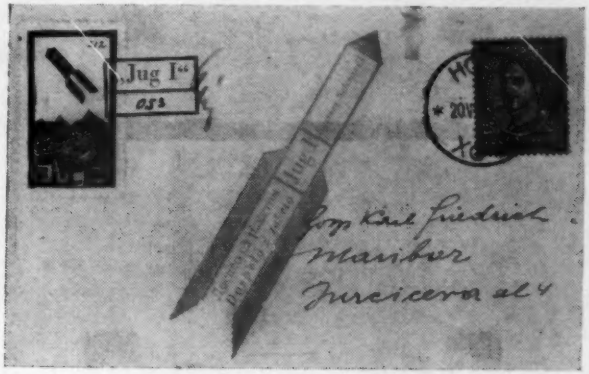
The philatelists among the visitors and members looked longingly at the truly unique collection of Rocket Post Covers lent by Mr. F. J. Field, covering a period from 1928 to 1946 in no less than 12 countries. Many valuable historical specimens were apparent in this collection.

The Model Section

Models were few, but most impressive was that of the Expendable Tank-Step Rocket, depicted as a series of solid models mounted in a curve, and showing the successive stages in the placing of a vessel in an orbit about the Earth. The whole model was, in addition, of considerable artistic merit.

Small models, of remarkable workmanship, 1/50 scale, showed the comparative sizes of a man and the rockets W.A.C. Corporal and V2. Seeing these last two together, one could not help recalling the recent American project when a W.A.C. Corporal was used as a second step on a V2 and reached a height of about 250 miles.

Selection of Rocket Post Exhibits.



Rocket Trial in Jugo-Slavia, 1935.

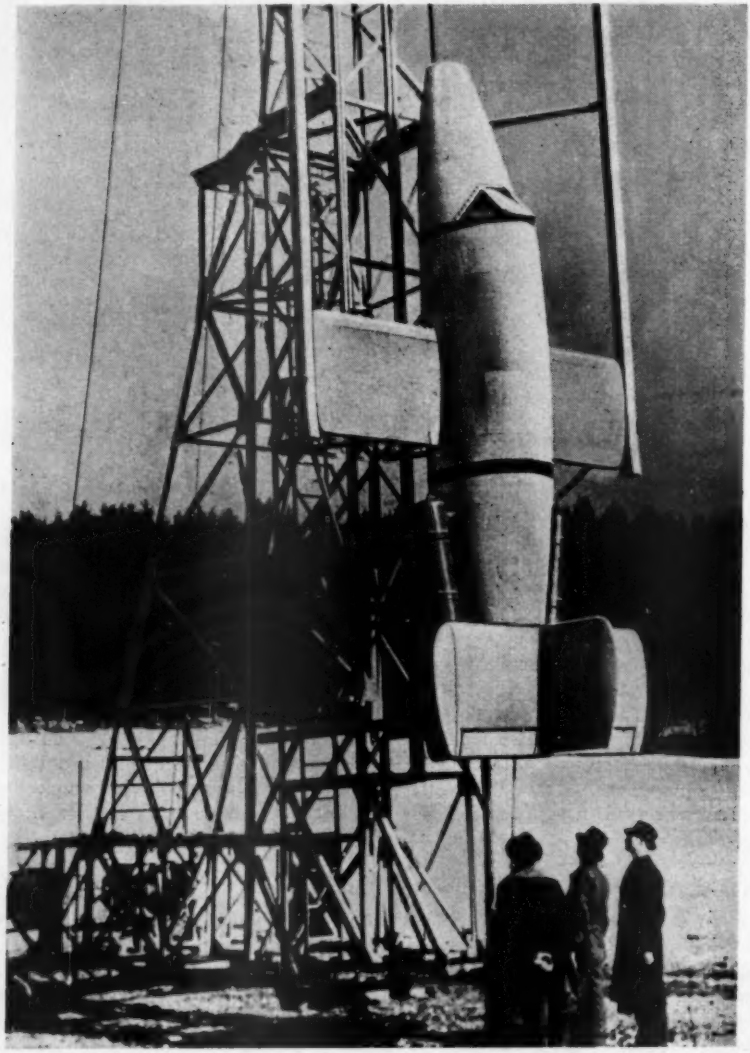
A sectional Walter 109–509 A2 motor caused much interest and this was further illustrated by a diagram of its fuel system and a pictorial drawing of the aircraft to which it was fitted—the Me. 163 B.

In the Lunar Section, an attempt by the present author to show the actual appearance of the Moon from a height of only 500 miles, took the form of a scale model in colour, of the region between Plato and Archimedes. Lighting was arranged to simulate the bluish sunlight which must illuminate our satellite and the model was viewed through a binocular "space port" in such a way that the jagged Lunar limb could be seen. The angle of the view was purposely selected as one which is impossible with a telescope and will, in reality, only be seen by a Lunar expedition. An anxious moment arose before the commencement of the Conversazione because of the lighting system of the model. Much blue oil paint had been coated on the lamps and the fierce heat of the filaments "cooked" the oil very thoroughly. A smell strongly reminiscent of fried fish and chips rose from the Lunar surface to the continuous accompaniment of blue smoke. Suggestions from a nearby Fellow that our visitors would think the moon possessed an atmosphere whose main constituent was fish and chips were, of course, inevitable.

A Gift of Classical Astronautical Literature

To end the tour of exhibits mention must be made of the magnificent presentation of classical astronautical literature by our new Hon. Fellow, M. Robert Esnault-Pelterie. This valuable collection of modern and historical volumes was a magnet to the bibliophiles among us. Many who were there, including the writer himself, regretted their sad lack of linguistic knowledge, whilst examining these exhibits.

The work of a society such as ours, in the development and expression of the Interplanetary Idea—encompassing so many branches of learning—leads inevitably to a great deal of specialization. There follows the danger of



The "Natter," a German war-time experimental rocket interceptor aircraft.

unbalanced outlook with regard to individual lines of investigation, which has hampered so many worth-while projects in the past. A certain answer is the Conversazione with its pooling, even for a short time, of *all* the facts, so that each may be judged and discussed in the light of others, achieving as we did on October 1, some measure of balanced enlightenment.

MAX W. WHOLEY.

ASTRONOMICAL FILMS*

A summary of Mr. Ovenden's commentary on the films shown at the Society's Conversazione held in London on October 1, 1949.

(*a*) Solar Prominences

This film was produced by Professor D. Menzel, at the High Altitude Observatory of Harvard College, at Climax, Colorado. It was taken with a coronagraph incorporating a polarizing filter, and shows the motions of the solar prominences at the limb of the Sun.

These solar prominences could first be observed only at total eclipses of the Sun, when they appeared as large "flames" at the limb. They are not visible in white light other than at an eclipse, due to their faintness and the scattering of the Sun's light by the Earth's atmosphere.

The application of the spectroscope enabled spectra of prominences to be obtained without an eclipse, the first being taken by Janssen in 1868. The typical prominence spectrum is an emission spectrum, with all the light of the prominence concentrated in a few discrete wave lengths. With very few exceptions, these lines correspond in wave length to absorption lines seen in the normal solar spectrum, and by far the most prominent line is the *Ha* line of Hydrogen, at 6,563 *A*, at the deep red end of the spectrum. Thus, if prominences could be seen without a spectroscope, they would appear red.

It then became clear that if all the spectrum, except just a small range of wave lengths about *Ha* could be cut out, the prominences would appear bright, as the intensity of scattered light would be greatly reduced without appreciably affecting the intensity of the prominence. Early observations were made with a simple spectroscope with a wide slit, and observing in *Ha*, but the system was not satisfactory. In the spectrohelioscope, invented by Hale about 1900, a spectroscope with two narrow slits is used, the first to form the spectrum with a diffraction grating, and the second, situated in the plane of the spectrum, to select the narrow band of wave lengths required. The spectrohelioscope, however, can only show the form of a prominence (or other feature of the solar disc) if some scanning device is provided, as otherwise only a single slit of the Sun could be seen at one time. This, of course, reduces the intensity of the image as well as giving an optical definition which is a function of the slit width, i.e. breadth of wave length range. Satisfactory prominence photographs have been and can be taken with a spectrohelioscope, but the excellent results of films such as this can only be obtained by a system in which the light from a large area of the Sun is made monochromatic. Such a highly selective filter has been

* *Shown by courtesy of the Royal Astronomical Society.*

developed by Lyot, utilizing the doubly refracting properties of quartz. If a Lyot filter is placed in the optical train of an ordinary telescope of modest aperture (say 8 in.), an image of the Sun about 1 in. in diameter can be seen in light whose wave length is restricted to a small band about $1\frac{1}{2}$ *A* wide. A filter of this kind was used to make this film. As the brightness of the Sun's disc in *Ha* is greater than the brightness of the average prominence, an opaque disc is placed over the image of the solar disc, creating an artificial eclipse.

The nature of prominences is not certain. We know, of course, that they are not "flames" in the ordinary sense, the temperature of the Sun's surface being far too high for chemical reactions such as combustion to occur. The appearance is that portions of the material of the solar surface are shot out, due to some unknown cause. We know too, that at the time of a solar flare, atoms may be shot out, and some prominences are associated with flares. Some, on the other hand, are associated neither with flares nor even active regions near sunpots. Another difficulty is that frequently prominence material seems to be "created" far from the surface, and to stream *into* the Sun. This feature is particularly noticeable in some of the sequences of the film. Also, it is apparent that prominence material appears to stream along certain definite paths from certain points on the Sun's surface, sometimes going up and falling back along the *same* path. The distribution of these paths is strongly reminiscent of lines of magnetic force, and as sunspots have large magnetic fields, this is probably the explanation of the appearance of these paths. It has been suggested that prominences are giant electrical discharges in the outer regions of the solar atmosphere, and some colour is lent to this view by the recent development of the theory that solar flares are discharges also. A further possibility is that prominences are *cool* regions in the tenuous corona of the Sun, which we know to be at a far higher electron temperature than the solar surface, and it is possible that they owe their origin to the attraction by the Sun in its passage through space of large numbers of interstellar dust particles.

By *solar flares*, is meant those regions of the solar surface which when observed in *Ha*, suddenly brighten considerably for limited periods, perhaps from a few minutes to a few hours. They occur in association with sunspots, and have a number of important terrestrial effects. The ultraviolet light which they emit so changes the ionization of the Earth's atmosphere that radio waves of short wave length are absorbed, and at such times short-wave radio communication over long distances on the Earth is impossible (*fade-out* has occurred). Flares also emit particles which take about a day to reach the Earth, and on so doing affect the upper atmosphere to cause marked changes in the Earth's magnetic field (i.e. magnetic *storms*). While prominences are seen on the disc, one of the sequences in the film has caught a flare just at the limb. Its sudden appearance is followed by the ejection of a surge prominence. While the atoms we observe here are hydrogen atoms, which seem to return to the Sun, the process is probably similar to the ejection of calcium atoms, which are those believed to cause the magnetic storms.

It is noticeable in the film that while some prominences are relatively quiescent, others are active and alter rapidly. In particular, the sequence showing the expansion of the largest prominence ever photographed is

particularly interesting, the prominence reaching over some one-third of the solar circumference. The film has, of course, been speeded up some 500 or 1,000 times, but when it is realized that the diameter of the Sun is 864,000 miles (the frame of the film being 500,000 miles), it can be appreciated that even then the film hardly does justice to some of the phenomena. Velocities of up to 500 km./sec. (well over a million miles an hour) are sometimes observed in eruptive prominences, and I have observed such prominences myself in the spectrohelioscope.

Although I have seen these films many times before, I never tire of the repetition, and I am sure you will agree with me in that they are truly striking.

(*b*) Rotation of Jupiter

This is a very much shorter film made at the Lick Observatory, which consists of a number of photographs of the planet taken at different times, speeded up in a final sequence to show the rotation of the planet about its axis.

Jupiter does not appear to rotate as a solid body. Two systems are recognized, System I (the equatorial system), having a period of 9 h. 50 m. 30 s., and System II, having a period of 9 h. 55 m. 40 s. The exact relationship between the two systems is not known, nor is it certain whether the observed difference of period is a phenomenon of the planet's atmosphere or not.

The film also shows the passage of one of the satellites near the disc, with the consequent production of shadow upon the planet, in a manner analogous to the shadow of the Moon on the Earth's surface during a solar eclipse.

LIST OF EXHIBITS AT THE CONVERSAZIONE

Modern Rockets Section

(*a*) German Rocket Development.

Photographs.

Rheintochter R1 (three photographs).
Rocket-powered glider bomb.
"Natter" rocket interceptor.
Messerschmidt 163.
Walter 109–509 C rocket unit.
Turbine fuel pump for 109–509 unit (three photographs).
Control-valve and pressure balancer for 109–509 motor.
Me 163 rocket-propelled aircraft.
Walter 109–509 A. 2 rocket motor.
Me 163–B rocket fighter.
Rheinbote.
German and American rocket motors (five comparison photographs).
A. 4 motor compartment shell.
A. 4 rocket, with motor compartment and shell removed.
" " fuel injectors.
X-4 air-to-air missile.
HWK 109–500 A.T.O. unit (three photographs).
Rear of X-4.
Schmetterling Hs. 117 (two photographs).
Hs. 293 guided missile.
HWK 109–507-B rocket unit.
Feuerlillie F-25 (two photographs).

Diagrams.

A. 4 long-range rocket (cut-away view).
" fuel-feed system.
" " " (coloured diagram).

Adapted V2, coloured drawing showing features of adaption for high-altitude research.
Two-step high-altitude rocket.
Tail-end of Me 109–509.
109–509 unit.
109–507 unit.
Cold A.T.O. unit.
Hot A.T.O. unit.
Cooling systems.
Fuel feed.
Injectors.
Walter 109–509 A.1 fuel system.
,, 109–509 C fuel system.
,, 109–509 performance curves.
Rh. Z 61/9 Rheinbote performance curves
,, Trajectory and performance (two charts).
,, Recoilless launcher.

(*b*) American Rocket Development.

U.S. Army ionospheric rocket (W.A.C. Corporal).
,, ,, ,, ,, exhaust trail.
Rocket-firing landing craft at Tarakan.
U.S. Navy "Bat" rocket.
Lockheed P. 80 Shooting Star, A.T.O. units in operation.
The Rotochute.
,, ,, speeds and altitudes attainable (charts).
Mechanical Calculating machine at Dahlgreen, Virginia, used for guided-missile calculations (three photographs).
V2 tests from U.S.S. *Midway* (four photographs).
N.A.C.A. "Tiamet" (three photographs).
Ascent of the "Aerobee" (five photographs).
Curvature of the Earth taken from an "Aerobee" rocket (two composite photographs).
Scenes of the Earth at various heights taken from an "Aerobee" rocket (three photographs).
Inyokern 450-ft. launching ramp.
,, 1,500-ft. rail launching ramp.
,, general views of the Naval Ordnance Test Station (two photographs).
American V2 tests in New Mexico (four photographs).
Launching of Convair 774.
W.A.C. Corporal (five photographs and pictorial sketch).
Launching of the "Private 'A'" (two photographs).
"Viking" high-altitude sounding rocket (pictorial sketch).
Boeing XB-47 rocket-assisted aircraft (two photographs).
Bell X-1 rocket-propelled aircraft.

(*c*) British Rocket Development.

De Havilland "Sprite" A.T.O. unit (three photographs).
Vickers' transonic missile (pictorial cutaway view).

Historical Rockets Section

Chinese rocket, A.D. 1232 (diagram).
Caricature of Golightly's projected "Aerial Steam Horse."
Steam reaction car (diagram).
Battey's rocket airship (diagram).
Boxer two-step, life-line rocket, 1855 (diagram), and photograph of modern life-line rocket and launcher).
Congreve military rockets (diagram).
Dr. Winkler's liquid-fuel rocket, 1932 (photograph).
Oberth Spaceship. A "still" from the UFA film "Frau im Mond."
Tiling Winged Rocket (diagram and photograph).

Interplanetary Section

Lunar space-suit (pictorial view).
,, ,, (sectional view).
,, ,, details of air plant (two diagrams).

Data of aerophysiology.
Space-gun trajectories.
Earth-Moon orbits.
Stationary orbits.
Interplanetary orbits, Mars and inner planets.
Co-tangent projection diagrams.
Telecontrolled Moon voyage (two diagrams).
Double sub-orbit Earth-Moon trip.
Spaceship manœuvres. deflection, approach, and touch-down.
Solid-fuel Moon-rocket.
Forward section, pre-war B.I.S. spacehip (pictorial view).
Design of Lunar spaceship (cut-away view).
Appearance of spaceship at various stages of flight.
Structural features of forward section of a spaceship design.
B.I.S. Coelostat (two diagrams).
"Megaroc" man-carrying rocket (cut-away pictorial view).
" " " structural features.
" " " phases of flight.
Spacestation (pictorial view).
" structural features.
Launching a rocket from a floating platform (pictorial view).
Landings on Lunar surface (pictorial view).
Pre-war B.I.S. spaceship, structural features (diagram).
" " " parachute descent of container on arrival at Earth (drawing).
" " " arrival on Moon (imaginative drawing).
Expendable-tank step-rockets (two diagrams).
Scenes from "Spaceship I Departs" (four photographs).
Cartoons from various sources.
Collection of classic astronautical literature, presented to the Society by R. Esnault-Pelterie (Hon. Fellow).

Lunar and Astronomical Section

First quarter of the Moon (photograph).
Map of the Moon, showing main surface features.
Part of 100″ reproduction of Wilkins' 300″ map of the Moon.
Composite photograph of the Southern region of the Moon, and key.
Sunrise in the region of Aristarchus (three photographs).
Mare Imbrium region (photograph).
Mare Nectaris region (photograph).
Sunrise on region of Sinus Iridium (three photographs).
Main mountain ranges of the Moon (two photographs).
Northern portion of the Moon, composite photograph and key.
General appearance of the moon (three photographs).
Region of Schickard, Wargentin, and Bailey (photograph).
Various regions of the Moon (eleven photographs).
Saturn (seven photographs).
Lunar surface and sky (painting).
Demonax (drawing).
Gassendi (drawing).
Bailly (drawing).
Riccioli and Sven Hedin (drawing).
The Sea of Crises.
Aristarchus.
Plato.
Rainbow Bay (Sinus Iridium).
Lake of Death.
} A series of five paintings.
Photograph showing curvature of the Earth, taken from a balloon, "Explorer II" (1936).

Rocket Posts Section

Australia: Cover and photograph of rocket by Queensland Air Mail Society, in August, 1935 ("Wreck rocket mail").
Cover and photograph of rocket, by Australian Rocket Society to commemorate Silver Jubilee, October 28, 1935.

Austria: Fredrick Schmiedl, Cover for balloon ascent, 1928.
„ „ First public rocket mail, September, 1931.
„ „ Rocket V8, cover, fired at night in October, 1931.
„ „ Two-step rocket V17, cover, fired in December, 1933.
„ „ Two post-cards, one showing descent of rocket by parachute.

Belgium: Zucker, from Ostend to Dover (picked up at sea).
Cover for rocket experiment carried on in 1946.

Cuba: Two covers from official Cuban experiments in October, 1939.

Germany: Zucker, cover showing three rocket stamps, November, 1933.
„ two covers issued in 1934.
Photograph of a leaflet which fell near Manchester from a V1, in December, 1944.

Gt. Britain: Zucker, experiments, photograph and cover, Rottingdean, 1934.
„ „ „ „ „ Hebrides, 1934.

India: Two covers by Indian Air Mail Society, April, 1935.
„ „ „ „ „ „ „ June, 1935, and February, 1937.

Italy: Zucker, cover for experiment in October, 1934.

Jugoslavia: Weiss experiments, August 20, 1935.

Holland: Zucker, cover, March, 1935, and cover from a series of experiments, December, 1934 to April, 1935 by Roberti.

Switzerland: Zucker, cover from rocket fired from a motor yacht, June, 1935.

U.S.A. Two covers, Professor Goddard's firings over the Rio Grande, July, 1936.
Lake Greenwood experiments. Cover and photograph, February, 1936.

Model Section

Expendable-tank step-rocket, display, data, and pictorial views.
V2.
W.A.C. Corporal.
Man in space-suit.
Tiling winged rocket.
} Small models to illustrate comparative sizes (scale 1 : 50).
Globe of Mars.
Lunar panorama, Mare Imbrium and Region of Plato and Aristarchus. (Lighted Model.)

Other Exhibits

Walter 109–509 A2 motor, Turbo-pump assembly (cut-away).
„ „ „ „ combustion chamber (cut away).
„ „ „ „ Propellant injector.

Acknowledgments

E. Burgess: Photographs and drawings.
L. J. Carter: Photographs.
R. Esnault-Pelterie: Collection of classic astronautical literature.
Editor of *Aeronautics:* Collection of seven coloured drawings.
Editor of *Everybody's:* Photographic reproductions from that journal.
Editor of *Reynolds' News:* Photograph of a drawing of the pre-war B.I.S. space-ship.
Francis J. Field: Collection of rocket posts souvenirs.
K. W. Gatland and A. M. Kunesch: Photographs and model exhibit of the expendable-tank step-rocket.
J. Humphries and the Ministry of Supply for German rocket equipment.
N. Nicoll for scale models of V2, W.A.C. Corporal, Tiling winged rocket and coloured drawing of imaginative view from the Moon.
H. E. Ross and R. A. Smith: Photographs and drawings.
L. Sykes: Drawings.
M. W. Wholey, F. Brooker and J. Hornigold: Model of Lunar surface.

General Assistance: F. Brooker, E. Burgess, L. J. Carter, A. C. Clarke, A. V. Cleaver, A. E. Dixon, F. Fears, K. W. Gatland, J. Hornigold, J. Humphries, A. M. Kunesch, G. R. Ramsden, H. E. Ross, R. A. Smith, G. V. E. Thompson and M. W. Wholey.

"THE SPRITE"
THE FIRST DE HAVILLAND ROCKET

Earlier this year, Major Frank B. Halford addressed the fifth annual general meeting of the de Havilland Engine Co., of which he is Chairman and Technical Director, and said: "Beyond the scope of the gas turbine, which uses the air for combustion, we are convinced of the demand for rocket motors which carry their own oxygen supply, and believe they will be needed for special purposes in both military and civil flying. Accordingly, we are not neglecting this development." The first result of this policy to be announced is the "Sprite," a unit for assisting the take-off of large aircraft. Several B.I.S. members (including, of course, our Chairman) are among those who have been employed on this project; the following description of it is reproduced (by permission) from the company's house magazine *The de Havilland Gazette*, for August, 1949:—

"Provision is made for two 'Sprites' to be installed in the Comet should assisted take-off be found to be necessary for operations from high-altitude tropical aerodromes.

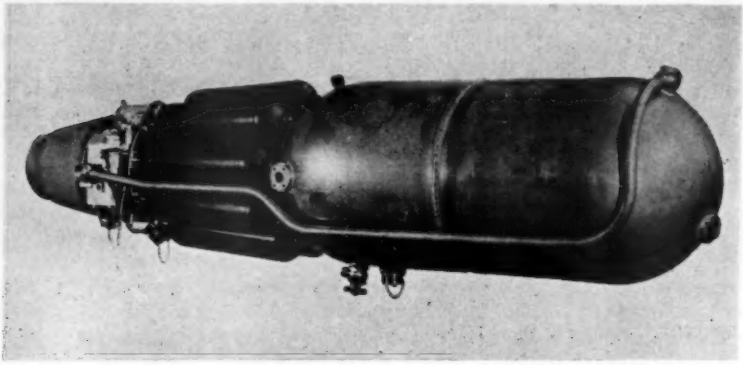
The need for a unit suited for general application to the new generation of turbo-jet aircraft, both civil and military, has been evident for some time. Three years ago the de Havilland Engine Co. began a general study of the application of rocket propulsion to aeronautics, based in the first instance on the extensive German data and experience. It soon became clear that the so-called "cold" hydrogen-peroxide liquid fuel rocket was simple and reliable and offered the most promising prospect for the evolution of comparatively simple units like the 'Sprite'; further, it was an essential stage in the wider programme of rocket research upon which the de Havilland Engine Co. has embarked.

The 'Sprite' gives a total impulse of 55,000 lb.-sec., *25,000 kg.-sec.* The thrust 'die-away' (arbitrarily quoted as from 5,000 lb., *2,270 kg.*, at nine seconds to 3,000 lb., *1,362 kg.*, at 12 seconds) is adjustable; it would also be possible to adjust the unit to give lower maximum thrusts (down to 3,500 lb., *1,590 kg.*) for longer periods.

Thrust is obtained by allowing a catalytic agent—in this case either sodium or calcium permanganate—to react on a solution of hydrogen peroxide of 80 per cent. concentration. This principle permits a very simple mechanical design for the unit. The temperatures are low and only one fluid is used at a high flow-rate, so that the reaction chamber need not be cooled and the propellant injection equipment is therefore uncomplicated.

The unit comprises a 39-gallon, *177-litre*, tank for hydrogen peroxide which is connected to a chamber of strong construction into which the catalyst is fed and in which the chemical reaction takes place. The resulting high-velocity jet of superheated steam and oxygen is then ejected through a nozzle, convergent at first but diverging in the last part of its length.

The 2½-gallon, *11·4-litre*, tank containing the catalyst is located around the extreme end of the nozzle. Immediately forward of this, and arranged as a



The "Sprite" is an assisted take-off unit giving 5,000 lb., *2,270 kg.*, thrust for approximately 12 seconds. It was on view for the first time at the S.B.A.C. Display and Exhibition at Farnborough in September.

saddle around the unit, are the control valves, and around the reaction chamber are nine bottles which carry, at a pressure of 3,000 lb./in.², *211 kg./cm.²*, the compressed air used to feed the propellants into the reaction chamber. The air is led first into an annular ring and thence through the various control valves. Delivery is controlled by the pilot through a mechanically-operated on/off air cock and by solenoid-operated air distributor valves, combined with an automatic reducing valve. The fact that these valves are operated by the pilot enables him to carry out a check at 750 lb., *340 kg.*, thrust to satisfy himself that the unit is working correctly before the aircraft moves off. Also, he is able to shut down the unit at any time during the reaction. Neither of these safeguards could be embodied in a rocket using solid fuels.

The fuelling of a unit such as the 'Sprite' with two liquids and with compressed air could be difficult, slow and dangerous, particularly since concentrated hydrogen peroxide might set fire to any substance—such as oily rags lying on the tarmac—which happened to contain a critical catalytic agent. The de Havilland Engine Co. have therefore designed a refuelling trolley which avoids danger as well as being convenient. It carries cylinders of compressed air and tanks for the two propellants. Refuelling can be done while the unit is installed in, or attached to, the aircraft, and self-sealing couplings of different sizes are provided for the tanks. The trolley has a reserve of compressed air for feeding the propellants as well as for charging the bottles.

The nature of rocket propulsion tends to create an impression of powerful and barely controllable forces in the lay mind, but in fact the 'Sprite' will be able to take its place as a simple and reliable ancillary to commercial or military aviation. Its handling and firing techniques for the operator and pilot are simple, and for the passenger, the firing of two 'Sprites' on a typical commercial aeroplane would result in an additional acceleration of only 0·1 g.

The 'Sprite' can be mounted internally in wing, nacelle or fuselage, or

externally in a streamlined cowling, and may be a permanent or temporary installation. Two side trunnions take the thrust load and a 'steady' trunnion is provided at the front of the hydrogen peroxide tank. Provision must be made in the pilot's cockpit for one lever, operating the compressed-air cock; one electric selector switch giving 'Check Thrust,' 'Full Thrust' and 'Off,' and one firing-button, which can be conveniently placed on the control column.

Empty, the 'Sprite' weights 350 lb., *159 kg.*, and charged for use, 925 lb., *420 kg.* The maximum diameter is 20 in., *0·508 m.*, and the length is 84 in., *2·14 m.* A detailed account of the unit and of the de Havilland control-valve system and of the safety measures which it embodies, will be given in an early issue of the *Gazette*.

A spritely take-off is the aim."

THE RESEARCH SCENE—3

By Kenneth W. Gatland

In the first article in this series it was stated that from time to time review would be made of design studies published by other research groups. A recent investigation by the Engineering Committee of the Pacific Rocket Society comes under this heading: subject, The *Manned Circum-Lunar Space-Craft*, summarized by E. G. Ewing in *Pacific Rockets*, Summer-Fall combined issue (Vol. 3, Nos. 1 and 2, pp. 19–24).

It should be emphasized that this investigation was aimed at no more than assessing the order of magnitude of an initial interplanetary project, as a logical step beyond (*a*) the Earth Satellite Vehicle, (*b*) the pilotless moon-rocket, and (*c*) the man-carrying high-altitude rocket for initial physiological experiment. The preliminary estimates were to provide an adequate technical basis for the construction of a demonstration model.

The study is therefore in some ways similar to the one being pursued regarding the *Expendable-Tank Step-Rocket*, the main difference being that whilst we have speculated in part on a form of *atomic drive*, the Pacific Rocket Society have attempted to evaluate their conception on the basis of chemical propellants alone.

The two proposals should therefore bear interesting comparison, but unfortunately a rather bad mistake concerning the mass-ratio to be used in calculating the take-off mass resulted in the P.R.S. obtaining highly fictitious values for the chemical rocket.

The design is based on liquid fluorine and hydrazine in a conventional 7-step arrangement, with final Earth landing made by a supersonic glider from a 500-mile altitude orbit. Figures from which the all-up weight is derived were quoted as follows:—

Required mass-ratio (effective)	= 8,000.
Mass of landing rocket (payload for step 7)	= 1·5 tons.
Mass of empty carcass (step 7)	= 0·9 „
Step 7 plus payload	= 2·4 „

The P.R.S. then mistakenly take the initial mass M_o of the circum-lunar rocket as:

$$M_o = 8{,}000 \times 2{\cdot}4 \text{ tons.}$$
$$= 19{,}200 \text{ tons.}$$

In fact, on the basis of their own design parameters, the correct M_o is more than an order of magnitude greater! This is because the *effective* and the *true* mass ratio are not the same thing.*

No chemical rocket of the type envisaged could be built to fulfil the objective, despite conservative assumptions of the required characteristic velocity (26 km./sec.—16·1 miles/sec.) and of the effective accleration to be employed (1 g. average). The study rather serves to confirm *our* conclusions about the inadequacy of chemical propellants and "simple" step-rockets, and though our friends of the P.R.S. may—in their turn—feel that we have been optimistic in postulating an atomic reactor of 10 km./sec. (32,790 ft./sec.) V_e for the main propulsion stage of the *Expendable Tank Step-Rocket*, they should recognize that if the target performance is to be attained, the choice is largely inevitable.

The use of the Orbital Stage Technique, it is true, may eventually permit a Circum-Lunar flight with chemical propellants, but, even so, exhaust velocities will need to be considerably greater than those attainable, or even foreseeable today.

These schemes, in any event, are nothing more than tentative approaches to the problems involved and are bound to be revised as our technology develops. Provisional though they may be, however, they do serve as an interesting basis for discussion.

The Aerobee Programme

The Aerobee is a rocket specifically designed for use in upper atmosphere research. It was developed by the Aerojet Engineering Corporation of Azusa, California, and the Douglas Aircraft Co. under the technical supervision of the Allied Physics Laboratory of the Johns Hopkins University.

A Bureau of Ordnance contract for the design, testing and fabrication of 20 Aerobee-type rockets was initially awarded in May, 1946. The proposal was to pattern the Aerobee generally on the successful WAC-Corporal rocket, but with instrument volume and altitude specifications more suited to high-altitude research requirements. The Office of Naval Research was also interested in a rocket of this type and agreed to contribute one-fourth of the total Aerobee contract amount in return for five of the 20 vehicles, to be used by the Naval Research Laboratory.

Objectives of the Aerobee Programme were stated as follows:—

(*a*) To provide a relatively inexpensive vehicle for research in the physics of the upper atmosphere.

(*b*) To advance engineering experience and practice in the design, testing and launching of liquid-propellant rockets, while at the same time making available a proven missile of potential military value as a basis for an anti-aircraft weapon.

* See "Calculation of Take-off Mass" to appear in the January, 1950, *Journal*.

(*c*) To provide experience within the United States Navy and its contractors in the practical handling, servicing, fueling, launching and tracking of rockets of potential military type, including shipboard launching techniques.

A diagram of the rocket is shown in Fig. 1. The equipment space is within a thin ogival-shaped aluminium nose-cone and a useful payload of 70 kg. (154 lb.) can be carried to an altitude of about 115 km. (71·4 miles).

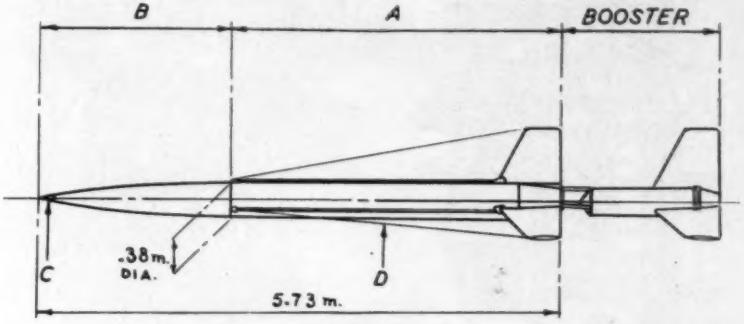


FIG. 1.

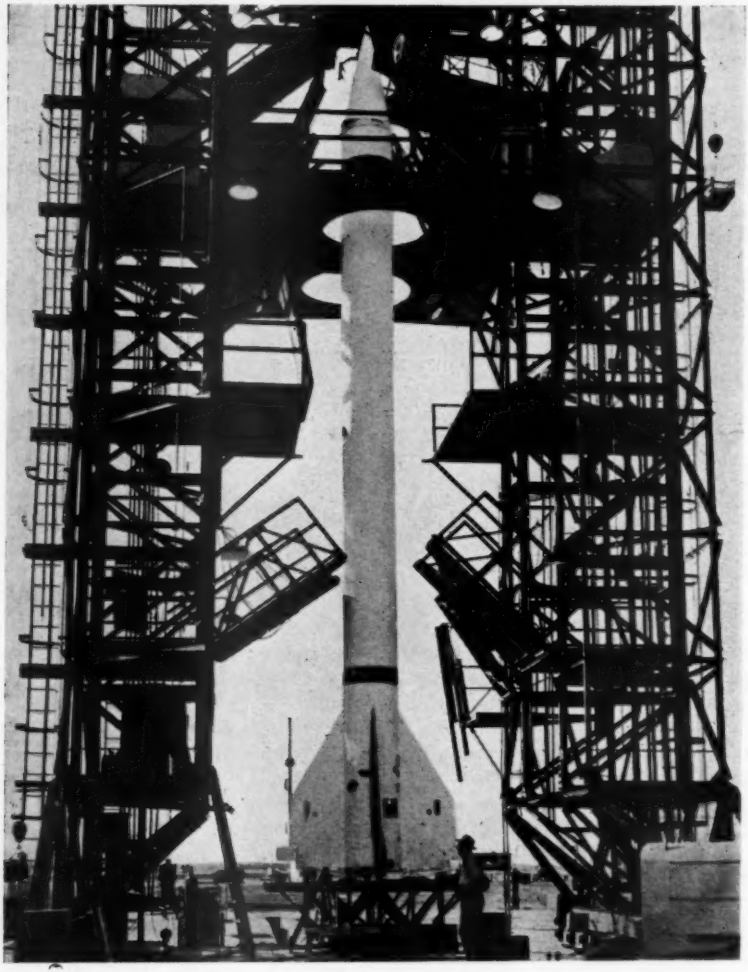
The Aerobee rocket. Note the use of thin thrust webs between the booster and the main missile, which allow both units to fire simultaneously. *A* — Propellant tanks and rocket motor: *B* — Instrumentation cone and recovery parachute: *C* — Telemetering transmitter antenna: *D* — Receiving antenna.

With an overall length of 5·73 metres (18·8 ft.), the rocket's maximum diameter is 0·38 m. (1·25 ft.). A solid-fuel booster is fitted behind the main propulsion stage, but is separated by thin thrust webs so that both units can operate simultaneously, the exhaust from the Aerobee motor being deflected outwards by a cone on the head of the booster.

The booster assists at take-off to bring the velocity rapidly up to about 305 m./sec. (1,000 ft./sec.), then jettisons; propulsion of the main missile continues for 45 seconds. At the time of cut-out, the rocket's velocity is approximately 1,250 m./sec. (4,100 ft./sec.) and the altitude about 28,975 m. (95,000 ft.).

The Aerobee is unguided, but possesses arrow stability by virtue of its three fixed fins and proper location of its centre of mass. Its trajectory is controlled simply by tilting the 42·7 metres (140 ft.) launching tower in accordance with wind data obtained from meteorological balloons.

Initially, data was retrieved from the rocket by two methods: (*a*) radio transmission from a compact 85-mc. telemetering set developed by the APL, and (*b*) physical recovery from the impact wreckage. Explosive separation of the tail-end structure from the remainder of the hull was arranged for a suitable altitude on the descending path of the trajectory. The tail-less portion of the missile is thus made aerodynamically unstable with the effect that it tumbles to earth with a velocity not exceeding 45·7 m./sec. (150 ft./sec.). Certain specially armoured equipment, such as photographic film, has been successfully recovered.



U.S. Navy Viking Rocket in Servicing Gantry.

The rocket is 45 ft. long and the loading rack around it has drawbridge-type platforms to make it possible to work on any part of the rocket while still in its vertical position.

The first live firing of the Aerobee occurred on November 24, 1947, following the firing of three dummy missiles containing no sustaining motor. A second, more satisfactory flight on March 5, 1948 (the first was terminated deliberately by radio command after 35 seconds, because of excessive yaw at take-off) resulted in a summit altitude of 113,460 metres (372,000 ft.) and yielded valuable data.

The rocket has proved itself so successful in operation that the United States Air Force placed an independent order for 60 Aerobees for launching at the Holloman Air Force Base at Almagordo, New Mexico. The new programme was initiated by a firing on August 16, 1949.

All rockets are now equipped with a ribbon-type parachute for recovering the instrument compartment.

Thirty colleges and research institutions will be responsible for handling various components of the instrumentation and evaluation during the tests. The objects of the programme are: (*a*) to determine the relation between solar activity and weather changes; (*b*) to perfect the design of future guided-missiles, and (*c*) to provide Air Force personnel with experience in handling ground-to-air rockets.

The Air Force is also experimenting with delayed opening parachutes to bring recording instruments safely to the ground from A-4 rockets at altitudes up to 100 miles. A 9·15 m. (30 ft.) diameter pilot parachute is stated to eject from the detached instrument head at the peak trajectory whereupon, 80 km. (50 miles) lower, increasing density causes the initial 'chute to open fully, dragging out the main 30·5 metres (100 ft.) canopy, which completes the descent.

Second Viking Fired

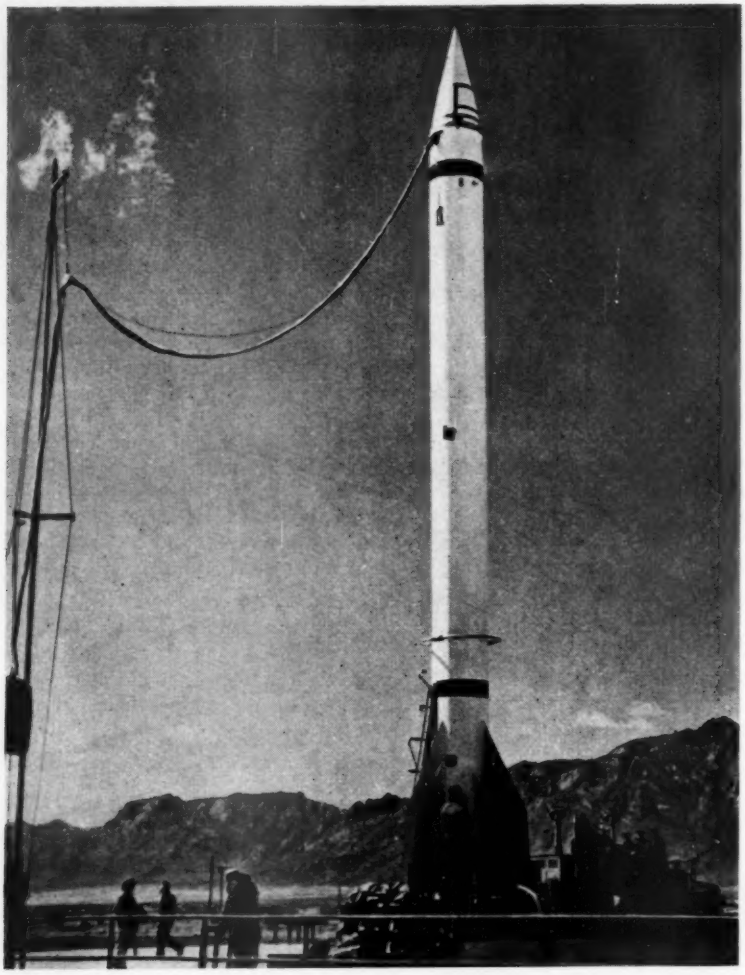
The U.S. Navy's new Viking rocket, fired recently for the second time at White Sands, New Mexico, attained an altitude of 51·3 km. (33 miles). This performance is less than that of its predecessor (the first Viking reached a height of 82·8 kms. (51½ miles), but it appears that stability and control were the main reasons for the test and the thrust period was only 49 seconds, although sufficient propellant for a run of 65 seconds was carried. In the previous experiment, 53 seconds of a similar load was consumed. Failure of the rockets to consume their full tankage—whether by accident or design—has not been explained. The third firing will concentrate on engine performance.

The Navy plans to launch a total of ten Vikings in its current research programme.

Spherical Temperature Recorder

A novel instrument for obtaining direct measurements of temperatures in the upper atmosphere (to altitudes above 112·6 kms. (70 miles) is reported under development by Dr. Severin Raynor, senior scientist at the Armour Research Foundation, Illinois Institute of Technology, Chicago.

The device is described as a gyro-stabilized metal sphere, containing recording equipment, which is ejected from the rocket during the ascent—when the velocity has risen to approximately 804 m./sec. (1,800 m.p.h.). In addition to



U.S. Navy Viking Rocket in firing position.

A cable attached close to the nose of the research rocket transmits the impulse to start the rocket on its flight. At present, the Viking is purely a research instrument for obtaining information in cosmic rays, atmospheric composition, radio propagation, photography and spectroscopy. The free-flight missile was designed and built by the Glenn L. Martin Co., of Baltimore, Maryland. The power plant was developed and manufactured by Reaction Motors, Inc., of Dover, New Jersey.

the three stabilizing gyroscopes, the unit consists of several temperature sensors, or thermocouples, and a camera for recording data.

The gyros are designed to keep the sphere steady both inside the rocket and after it is in free fall. To achieve this, the sphere is free to turn on supporting rings consisting of halves held together by explosive bolts which, after ejection from the rocket, are discarded by firing them off electrically. The sphere then falls freely whilst measurements are made.

The radiation measuring device consists of 14 buttons—each containing a temperature sensor—located on the surface of the sphere; readings are recorded on 16 mm. film using a special slow-speed camera. A watch mechanism times the recording.

As the device falls back into denser atmosphere, the camera, which is attached to a 400-megacycle transmitter for purpose of tracking, is itself ejected, whereupon a ribbon parachute opens, checking its fall, and aids in recovery.

The project at the Foundation is sponsored by the U.S. Air Force Air Material Command.

The Consolidated-Vultee "Lark"

Although flight trials of the *Lark*, a ship-to-air missile developed by Consolidated-Vultee Aircraft Corporation for the U.S. Navy, were commenced in December, 1947, it was only recently that initial details were released by the Navy Bureau of Aeronautics. The missile, which should be available in quantity for the Fleet by 1950, has a bi-fuel rocket motor, but is assisted at take-off by two solid-fuel units. Performance figures are still classified.

More Dollars for Supersonic Research

The United States Senate unanimously approved on August 12, 1949, the Bill authorizing a $311,000,000 expansion of supersonic aircraft and guided-missile research facilities. The Bill allocates the Air Force $150,000,000 for the basic construction of an engineering development centre to be located somewhere in the west of the United States, providing additionally for the construction of 22 transonic and supersonic wind-tunnels at an estimated cost of $161,040,000.

Seen at Farnborough

The celebrated annual S.B.A.C. Air Show at Farnborough this year gave some hint of progress in British rocket development.

First, on the de Havilland stand, was the *Sprite* "cold"-type liquid-fuel A.T.O. motor. This most compact and efficient-looking unit has been developed for the Comet pure-jet airliner, but it is also likely to find application in military aircraft.

An experimental ground-to-air missile, shown in cut-away, was one of the Ministry of Supply exhibits. This is an alcohol-liquid oxygen rocket 6 metres (20 ft.) in length, with a solid-fuel booster; a thrust of nearly 454 kg. (1,000 lb.) is exerted by the main motor for 25 seconds, sufficient to maintain a flight Mach. No. of 1·4. The propellants are fed by the explosive cartridge technique, in which gas pressure is exerted behind pistons in the tanks. Aerodynamic surfaces are incorporated and the missile will be controlled by a direct radio link.

The project represents an early stage in the current British programme of rocket development.

Another ground-launched missile on the M.O.S. stand was for wing-flutter research at high sub-sonic velocities.

Swedish Guided-Missiles

A press statement by the Chief of the Guided-Missile Department of the Swedish Air Force has confirmed the development of guided-weapons for the Swedish Air Force and also for the Coastal Artillery under Naval command.

Rocket Development by the Soviet

An unidentified German rocket engineer who recently escaped to western Germany after three years' forced service with the Russians, has described his experiences. He claims to have visited the Soviet Central Institute for Guided-Missile Development in Moscow and to have observed sites for long-range rockets under construction in Eastern Germany. Among his statements, which should be treated with the utmost reserve, are the following (according to *Inter Avia*):—

"The Russians are preparing to bring V-2 bases into action at a few minutes' notice. Plans for both static and mobile bases have been worked out in detail and static bases for one and three batteries have been placed all over Eastern Europe; each is supplied with all necessary calculations for firing its missiles into designated territories in Western Europe. Five single-battery launching sites are already completed and six three-battery bases are now under construction." The German engineer claims that: "Four of the completed single-battery bases are in the Soviet Zone of Germany; two in the State of Mecklenburg aimed at Southern Sweden; the third south of Erfurt aimed at the Rhine river crossings and bridgeheads near Cologne, Düsseldorf and the estuary of the river Scheldt; and the fourth, near Guben aimed at the northern part of the Soviet occupied Island of Rügen." He asserts that "the completed base is located east of Pilsen, Czechoslovakia, and covers the Brenner Pass." Three of the three-battery bases now under construction are stated to be: "within a 32 km. (20-mile) radius of Stettin, aimed at the German Bay, the Island of Sylt and the Dutch coast; three more are being built near Hradec Kralove (Königgratz), Czechoslovakia, to cover the Balkan countries and the Adriatic coast." The claim is also made that "the Russians are experimenting with mobile firing stations mounted on F.M.S. trains as developed by the Germans during the war."

Two recently completed 40,000-ton battleships of the Sovietoki Loyuz class are stated to be equipped with launching ramps for guided-missiles.

NOTES AND NEWS

Essay Competition

We have frequently invited, in these pages, contributions to the JOURNAL from ordinary members—letters to the Editor, articles, drawings, and any other items of interest. That invitation, of course, still stands; no guarantee of publication can be given, but the Publications Committee would be very grateful for any material submitted.

In an attempt to encourage contributions by suggesting a specific subject, we wish to announce an essay competition. A prize of one of a choice of books will be awarded to the authors of essays chosen for publication on any one of the following three subjects:—

(*a*) "Why Interplanetary Travel interests me."

(*b*) "How I believe Man will Reach the Moon."

(*c*) "What I think the B.I.S. should do to hasten the conquest of space."

The authors of prize-winning essays may select books from among the following:—

Ballistics of the Future (Kooy and Uytenbogaart).
One of the Harvard Books on Astronomy.
Rocket Propulsion Elements (Sutton).
Rockets and Space Travel (Ley).
The Atmospheres of the Earth and Planets (Kuiper).

The closing date for home entries is May 31, 1950, and for overseas entries June 30, 1950.

Entries will be judged by the Publications Committee, whose decision as regards the printing of essays in the JOURNAL must be regarded as final.

New Honorary Fellows

The Council takes very great pleasure in announcing that Honorary Fellowship of the Society has been conferred upon and accepted by the following pioneers of rocket engineering and interplanetary flight:—

M. Robert Esnault-Pelterie.
Mr. Philip E. Cleator.
Baron Ing. Guido von Pirquet.
Dr. Eugen Sänger.
Professor Dr. Wernher von Braun.

A short biography of Mr. Cleator, the founder of this Society, has already been given in the September JOURNAL (**8**, 5, 206) and we shall include biographies of our other new Honorary Fellows in future issues.

Dutch Rocket Symposium

The first Rocket Symposium of the Royal (*Dutch*) Institute of Engineers (Department Military Engineering), was held at The Hague, on June 14 last, when more than 140 members and guests were present, including a number of civilian authorities. The intention of the meeting was primarily to stimulate the study of liquid-fuelled rockets, and the five lectures were centred around this theme.

In order of delivery, the lectures were as follows:—

(1) A general Introduction, by General van den Bergh.
(2) "Rocket Performances," by Ir. G. de Koningh (a Fellow of the B.I.S.).
(3) "Aerodynamics of a Supersonic Rocket," by Dr. Greidanus.
(4) "Rocket Propulsion," by Ir. Sleutelberg.
(5) "Rocket Guidance," by Ir. Boxma.

The papers will be published (with English summary), in the October or November, 1949, R.I.E. transactions.

Our Long-suffering Secretary

One evening early in October, our Mr. Carter was just settling down to a few quiet hours of work for the Society (all he had to do that night was answer a dozen or so letters and pay a few bills), when the door-bell rang; his visitor was the representative of a local South London newspaper, who had a few questions to ask. Was the B.I.S. aware that the U.S. Navy had succeeded in sending a rocket to Venus, on January 14, 1947? Carter replied that we were not, and indicated that he thought such an event could hardly have escaped our notice, to say nothing of that of the rest of mankind.

Disappointed, but unshaken by this reception of his news, the reporter produced his evidence: a current copy of *Astounding Science Fiction*, with an article describing the event, entitled "The Aphrodite Project," and written by one Philip Latham. (Who is, incidentally, a well-known American member of the B.I.S., though he will not be found in the list of members under that name; we hasten to disclaim any responsibility for his more quixotic literary activities.)

In vain, our Secretary pointed out certain astronomical "deliberate mistakes" in the article, explained the extreme improbability of the U.S. Navy's choosing to make the first announcement of such a stupendous achievement in this way; surely the news would have been given first to some Congressional Committee, where it would have caused the maximum embarrassment and loss of face to the Air Force, in the traditional tepid war between the American Services? He might have added that this was not the first time that *Astounding* has printed such a "spoof" article, nor—for that matter—the first time one of their readers had been fooled. Finally, the still unconvinced journalist was persuaded to go away and invest 2d. in a 'phone call to the U.S. Embassy, the results of which we regret we are unable to record. Still more do we regret that Carter's first advice, to call up the Navy Department in Washington for confirmation, was rejected on the score of extravagance.

All of this serves to illustrate a most curious anomaly. It has been an uphill struggle to convince the world at large of the feasibility of interplanetary flight, and even to-day there are many lingering pockets of resistance to the idea; men of science have "proved" it impossible, newspapers have often had their little joke about it. Yet several million Americans panicked when Orsen Welles broadcast "The War of the Worlds" in 1938, and history repeated itself in this connection, in Ecuador earlier this year. We know of a Canadian family who thought a Bonestell painting of a spaceship on the Moon was a colour photograph, and now we have a British newspaperman accepting the evidence of a science-fiction magazine for a rocket flight to Venus. Can any reader explain this paradox of scepticism and credulity?

From the World's Press

Following all the recent newspaper accounts of the ideas of the C.R.S. at Toronto University, we learn that a group of students at Rhodes University, Johannesburg, are also interested in space-flight. They consider Venus should be our first planetary objective.

Professor Beezhold, of the University of Pretoria, has also been talking of rockets and their importance in future warfare, to the South African Association for the Advancement of Science, in Kimberley. He believed that within a reasonably short time a multi-step rocket could be shot to the Moon, but thought the problems of manned space-flight were immensely more difficult and that talk of nuclear-powered rockets was premature.

* * * *

After a visit to the U.S.A., the Astromer Royal (Sir Harold Spencer Jones) stressed the importance of rockets in research on conditions at high altitudes and in outer space. He considered, however, that it was not yet within the range of practical possibility to send a rocket to the Moon.

(It is at least something to find that astronomers and orthodox scientists now admit the value of rockets for scientific research and warfare. Their conversion to belief in space-flight is now only a matter of time.—ED.).

* * * *

Recent copies of South African papers have carried interviews with the founder of the B.I.S., Mr. P. E. Cleator, who is currently visiting that country and has already given a number of lectures and radio talks there on the subject of interplanetary flight.

* * * *

The *Financial Times*, in its September 5 supplement on the British Aircraft Industry, brought sympathetic mention of astronautics from an unexpected quarter, in an article discussing future aviation trends, including the eventual possibility of space-flight.

* * * *

On August 31 most British papers reprinted a story from the *Los Angeles Times*, to the effect that two senior officers at White Sands had observed space-ships at a height of 35 to 40 miles through a theodolite—"egg-shaped craft of fantastic size, travelling at incredible speeds of three to four miles a second." Commenting on this variation on the "flying saucer" theme, Brigadier-General Philip Blackmore (C.O. at White Sands), said: "Nothing of the kind has been reported to me and I am sure it would have been if it were true."

* * * *

Time, in its September 12 issue, announced that the U.S. Air Force's School of Aviation Medicine, at Randolph Field, Texas, has set up an interplanetary research section. Named the Department of Space Medicine, it is manned by three German scientists, and is studying the effects of acceleration, etc., with special reference to the phenomenon of "weightlessness," to which future space-ship crews will be subjected. Two of the researchers are Dr. Hubertus Strughold, a physiologist, and Dr. Heinz Haber, an astronomer and physicist.

It was also stated that the U.S. Navy is building a $5,000,000 centrifuge, capable of developing accelerations of 40 g. and with a radius of 50 ft., also with the object of obtaining data useful for astronautical, as well as aeronautical, purposes.

ABSTRACTS

EDITED BY J. HUMPHRIES

Is the Nuclear-powered Rocket Feasible?

(H. S. Seifert, *Physics To-day*, May, 1949, Vol. 2, No. 5, pp. 6–13, illus.).

To-day's problems in rocketry are first dealt with, combustion chambers, heat transfer and the ultimate performance of chemical propellants being the chief topics of discussion. Two possible schemes for utilizing nuclear energy are then considered, the first using a nuclear "boiler" to heat a working fluid which is then expanded through a nozzle in the normal way and the second using the energy direct in a "photon" rocket. In the first method the limiting factor is the working temperature and the first model produced would probably be no better than conventional chemical rockets, although there is always the hope that future models might be much better. The "photon" rocket is put forward not as a practical proposition, but as a topic for discussion. If a complete conversion from mass to energy could be achieved and directed into a unidirectional stream it would have a 100,000 greater momentum-producing efficiency than a chemical propellant. The author concludes that the rocket is one of the less practical applications of nuclear energy.

Flow through a Rocket Nozzle with and without Vibrational Equilibrium

(S. S. Penner, *J. App. Phys.*, May, 1949, Vol. 20, No. 5, pp. 445–7, refs.).

A procedure is outlined for calculating the maximum changes in the exhaust velocity of gases which can be introduced during flow through a rocket nozzle as the result of vibrational time lags. Representative calculations have been carried out for a number of propellant systems. These calculations indicate that the vibrational time lags cannot produce changes in exhaust velocity which exceed a few per cent. The numerical values of the changes are found to depend not only on the nature of the gases, but also on the occurrence or non-occurrence of chemical reaction during flow.

Stability of Concentrated Hydrogen Peroxide Solutions

(W. C. Schumb, *Ind. & Eng. Chem.*, May, 1949, Vol. 41, No. 5, pp. 992–1,003, illus., tabs., refs.).

Stability characteristics of concentrated hydrogen peroxide solutions have been studied at 50° to 100° C. over the range 70 to 90 weight per cent. hydrogen peroxide, in both the absence and presence of stabilizers; 50° C. proved satisfactory for the gas evolution method used to determine rate of decomposition of peroxide samples. Previous reports of high stability for very pure hydrogen peroxide at concentrations of 85 to 90 per cent. were confirmed. The temperature coefficient of the decomposition rate of unstabilized peroxide solutions was determined for the intervals 50° to 60° C. and 60° to 70° C., as $2{\cdot}2 \pm 0{\cdot}1$, which is believed to be approximately applicable over any 10° range between 50° and 100° C. Methods of preparing the surface of Pyrex containers for use with

concentrated hydrogen peroxide were developed which make possible obtaining reproducible measurements of the decomposition rate. Pure aluminium and pure cast tin were found to be suitable materials of construction. Vigorous agitation was without appreciable effect on the measured rate of decomposition of 85 per cent. unstabilized hydrogen peroxide. The importance of *p*H on rate of decomposition was emphasized by measurements with and without added catalytic ions. Data was secured on the catalytic effect of known concentrations of ferric or cupric ion in 85 to 90 per cent. hydrogen peroxide at 50° C. and on the required concentrations of stabilizers to restrain such catalytic action.

Carbon or Graphite as Materials of Construction for Rocket Motors

(J. A. Slyh, et al., *Battelle Mem. Inst., Rep. No. 35*, Oct., 1947; U.S. Dept. Comm., Off. Tech. Serv., P.B. L86498, $2·00, 17 pp.).

Data are presented covering a preliminary investigation on the use of a molybdenum alloy coating to prevent oxidation of graphite at elevated temperatures. The effect of small additions of sodium molybdate, alone and in combination with boric anhydride or with silica, in stabilizing an aluminium-graphite body, is reported. Some of the physical properties of specially prepared graphite specimens, determined at room temperature, are presented and compared with similar properties of commercial grades of graphite. (From *Fuel Abstracts*, May, 1949).

Ceramic Materials as Liners for Combustion Chambers of Rocket Motors

(Quarterly Report, Feb. 15–May 15, 1947. J. A. Slyh., *Battelle Mem. Inst., Rep. No. 25*, May, 1947; U.S. Dept. Comm., Off. Tech. Serv., P.B. L81754, $1·00, 8 pp.).

This report summarizes the work conducted at Battelle Memorial Institute during the period from Feb. 15 to May 15, 1947, on the investigation of ceramic materials as liners for combustion chambers of rocket motors. The appendix contains a bibliography and description of the torch-firing test. (From *Fuel Abstracts*, May, 1949).

Gypsum or Modifications of Gypsum as Combustion Chamber Liner for Special Short-term Rocket Motors

(J. A. Slyh, *Battelle Mem. Inst., Rep. No. 24*, May, 1947; U.S. Dept. Comm., Off. Tech. Serv., P.B. L81755, $1·00, 9 pp.).

This report presents data to show the resistance of specimens made from a mixture of plaster of Paris and graphite, and which were heated to different temperatures, to the action of the torch-firing test. Data are also presented on the testing of combustion chambers, lined with mixtures of plaster of Paris and graphite, in a rocket motor in which oxygen and hydrogen were used as fuel. The appendix describes the torch-firing test for screening ceramic materials of possible use in rocket liners and nozzles, with results in tabulated form. (From *Fuel Abstracts*, May, 1949).

Refractory Oxides as Liners for Combustion Chambers of Rocket Motors

(J. A. Slyh, *Battelle Mem. Inst. Rep. No. 28*, July, 1947; U.S. Dept. Comm., Off., Tech. Serv., P.B. L81978, $2·00, 14 pp.).

Data are presented on the thermal and physical properties of specimens made from fused magnesium oxide, bonded with shellac and on the thermal properties of specimens made from mixtures of fused magnesium oxide and silicon carbide, bonded with shellac. The preparation of two combustion-chamber liners, for the 25 A.L.D. 1,000 rocket motor, from magnesium oxide bodies, is also described. (From *Fuel Abstracts*, May, 1949).

Refractory Oxides as Liners for Combustion Chambers of Rocket Motors

(J. A. Slyh, *Battelle Mem. Inst. Rep. No. 23*, May, 1947; U.S. Dept. Comm., Off. Tech. Serv., P.B. L81979, $1·00, 10 pp.).

This report presents data on the thermal properties of magnesium oxide and beryllium oxide, each bonded with a mixture of plaster of Paris and a fused magnesium oxide bonded with shellac, with a view to their possible application in combustion chambers of rocket motors. An appendix covers torch-firing tests, with two tables. (From *Fuel Abstracts*, May, 1949).

Compressibility Effects in Two-phase Flow

(R. F. Tangren, C. H. Dodge and H. S. Seifert, *J. App. Phys.*, July, 1949, Vol. 20, No. 7, pp. 637–45, illus., tabs., refs.).

A gas-water mixture, when expanded through a de Laval nozzle, acts as a compressible fluid. A general expression for the flow process in an idealized mixture is developed. The general thermo-hydrodynamic relations for flow through a de Laval nozzle are developed. The magnitude of the velocity of an energy pulse or signal through the mixture is determined and is compared with the velocity of flow. Experimental results are compared with those predicted, using the equations developed.

The Craters of the Moon

(R. B. Baldwin, *Sci. Am.*, July, 1949, Vol. 181, No. 1, pp. 20–24, illus.).

The early work, particularly Schröter's, on the formation of the Moon's craters is first briefly reviewed. The author then presents evidence based on observations of the Moon's craters, meteor craters on the Earth, and man-made craters, showing that the Moon's craters are meteoric in origin. Logarithmic plots of diameter versus depth and rim height above original level versus diameter, show that all of these craters are on a smooth curve. Also the material in the rim around the Lunar craters would just fill the craters if it were replaced. On an energy basis it is possible to extrapolate from man-made craters and to estimate the probable meteor sizes to produce given crater sizes.

Space Flight

(L. R. Shepherd. *Jnl. of the Cambridge Univ. Engng. Soc.*, 1948, Vol. 18, pp. 35–56, illus., refs.).

An historical introduction is followed by an elementary mathematical analysis of the dynamics of reaction propulsion and space flight. Mass ratio requirements for extra-terrestrial flight lead to a consideration of the thermodynamics of rocket motors and a list of high performance propellants. Finally, the possibilities of using nuclear energy are dealt with.

The Mathematical Theory of the Motion of Rotated and Unrotated Rockets

(R. A. Rankin. *Phil. Trans. Roy. Soc.*, Series A, 1949, Vol. 241, No. 837, illus., refs.).

The first part of this paper is devoted to deriving the equations of motion for a solid propellant, high acceleration rocket, taking into account the various asymmetries that occur. The approximations which have to be made if the equations are to be solved are then discussed. The solutions of the equations with various forms of spin are dealt with and the conditions necessary for rocket stability are given. The rest of the paper is taken up with the evaluation of the parameters. Appendices contain tables of Fresnel and related functions required in the numerical evaluation of the deviations and numerical examples are given.

The Prospects of Jet Reaction Flight

(E. Saenger. *Inter Avia Rev.*, Vol. 3, 1948, Sept. No. 9, pp. 499–506; Oct. No. 10, pp. 557–565; Nov. No. 11, pp. 617–622., illus. Also in *J.A.R.S.*, 1949, March, No. 76, pp. 27–41; June, No. 77, pp. 59–74, 93–94, Sept., No. 78).

In the first part ram-jets and rockets are considered. The working principle of the ram-jet is given together with an indication of its performance capabilities. A discussion of the effect of jet efflux velocity on rocket aircraft performance leads to a consideration of rocket propellants and combustion chambers. The second part continues the detailed description of rocket motors with sections on the nozzle, combustion chamber walls and propellant supply systems. The supersonic aerodynamic performance of rocket aircraft at moderate Mach numbers ($M = 1$ to 5) is dealt with in some detail. Part 3 is devoted to the performance of both ram-jet and rocket-propelled aircraft, a section being given to the round-the-world rocket bomber. The series concludes with the atomic ram-jet and atomic rocket engines and the economic aspects of jet flight.

Design and Fabrication of Welded Lightweight Pressure Vessels

(J. J. Chyle. *J.A.R.S.*, Sept.–Dec., 1948, No. 75, pp. 90–106, illus., tabs.).

A number of factors are discussed which should be considered when designing welded light weight pressure vessels. These factors include selection of material, operating stresses, safety factor, selection of welding processes, inspection, heat-treatment, proof-testing and final qualification of the product.

Other Papers Noted

Flight Beyond the Earth's Atmosphere. F. H. Clauser. *Antiaircraft J.*, May-June, 1949, Vol. 92, No. 3, pp. 57–8. Elementary review of the propulsion requirements.

Hydrazine: Heat Capacity, Heats of Fusion and Vaporization, Vapour Pressure, Entropy and Thermodynamic Functions. D. W. Scott, G. D. Oliver, M. E. Gross, W. N. Hubbard and H. M. Huffmann. *J. Am. Chem. Soc.*, July, 1949, Vol. 71, No. 7, pp. 2293–7, figs., tabs., refs.

Rockets. W. Ley. *Sci. Am.*, May, 1949, Vol. 180, No. 5, pp. 30-39, illus. Commencing with a short review of the history and theory of solid propellant rockets, this article deals chiefly with liquid propellant rockets. Various propellants are discussed and several modern rockets described.

Rockets as Research Tools in Aeronautics. H. L. Dryden, *J.A.R.S.*, March, 1949, No. 76, pp. 3–8. A non-technical account of rockets applied to the propulsion of models in free flight for aerodynamic measurements at high speeds, to the propulsion of piloted research aircraft, and to the sounding of the upper atmosphere.

Metal Parts for Solid Propellant Rockets. L. G. Bonner, *J.A.R.S.*, March, 1949, No. 76, pp. 9–15, illus. Frequently extreme emphasis is placed on minimum weight for components and the total life of the rocket assembly is by ordinary standards extremely short. The engineering problems so introduced are surveyed from the points of view of material choice and design.

Ueber die Bewegung der Raketen. P. Matthieu, *Schweizer Arch.*, May, 1949, Vol. 15, No. 5, pp. 129–137, illus., refs. A new method of solving the equations of flight of a rocket.

Rocket-Fighters for Home Defence. Polygon. *Aeroplane*, Sept. 7, 1949, Vol. 77, No. 1995, pp. 282–3. A plea for rocket-fighters for home defence. Advantages and disadvantages of such fighters are discussed.

Britain's First. Aeroplane, Sept. 7, 1949, Vol. 77, No. 1995, pp. 278–9, illus. Technical details of the de Havilland assisted take-off rocket, the Sprite. Using hydrogen-peroxide as propellant and permanganate solution as catalyst, the unit develops 5,000 lb. thrust for nine seconds. It is intended for use on the Comet airliner.

Rockets Ahead. C. Pincher. *Discovery*, April, 1949, Vol. 10, No. 4, pp. 113–121, illus. A review of the present position and possible future of rockets in Great Britain, U.S.A. and Russia.

Tank Pressure from Combustion Chamber. E. F. Chandler. *J.A.R.S.*, Sept.–Dec., 1948, No. 75, pp. 119–121, illus. A short description of a method of providing a pressure balance line from a rocket combustion chamber to the propellant tanks and allowing the propellants to be injected due to the acceleration of the rocket.

Five-Pound Thrust Liquid Monopropellant Rocket. M. C. Sanz. *J.A.R.S.*, Sept.–Dec., 1948, No. 75, pp. 122–125, illus. Description of a hydrogen peroxide propelled rocket with a maximum attainable altitude of 40,800 ft.

REVIEWS

Analysis of Temperature Pressure and Density of the Atmosphere Extending to Extreme Altitudes

(By G. Grimminger. Pp. xv + 149, 45 tables and 44 figs. The RAND Corporation, 1500, Fourth St., Santa Monica, Calif., U.S.A. November, 1948. Price $2.85.)

In the first paragraph of the author's Introduction, he states that there may still be enough atmosphere beyond 300 miles high to affect the motion, over a long time interval, of a long-range rocket or even an artificial satellite. He adds: "It is also conceivable that estimates of the physical state of the atmosphere at extreme altitudes might be of some use—in various ways as yet unforeseen—in connection with certain problems which might arise in the study of interplanetary rockets."

That a monograph which starts off with such far-seeing statements should have been sponsored by the United States Air Force, as is stated on page iii, is encouraging. Presumably what they wanted, in return for their sponsorship, was a reliable table of physical properties at frequent height intervals up to the limit of the atmosphere. But, since practically nothing is known of the region beyond the ionized layers, they have got, instead, pages upon pages of alternative sets of values, each based on different assumptions, all highly tentative, about the state of the higher atmosphere.

This multiplicity of alternative data is the result of Mr. Grimminger's modest assumption that the authors of his 108 references, even when they contradict each other, are so much wiser than he that it is not for him to discard anything they say.

True, we start off from ground level with the assurance that, for the first 35 kilometres or so, direct measurements have been made. Temperature falls as we rise to the base of the stratosphere; it is constant through the lower stratosphere in middle latitudes but increases with height over the equator. Composition of the air remains the same, so density and pressure can be calculated from the temperature.

Further up, temperature can be deduced with diminishing certainty from a number of phenomena such as meteors, the auroral spectrum, ozone absorption of solar radiation propagation of sound from explosions, and reflection of radio waves, from ionised layers. The stratosphere appears to be hottest (77° C., or 350° K. if measured from absolute zero) at about 50 km., then cools again as we approach the ionised layers of the ionosphere. Of these layers, the E at 100 km. and the F_1 at 200 km. are usually present by day only, while the F_2 at about 300 to 400 km., is always there, and higher still a G layer is suspected.

As to the temperature of the ionosphere, eleven different authorities are quoted for middle latitudes. Nearly all of them deduce a great increase of temperature with height, and most, but not all, give values increasing beyond 1000° K. Grimminger assumes 1,100° K. at 300 km. and rules a straight line to this point from 375° K. at 120 km., a standard value recently adopted by the N.A.C.A.

For the equatorial ionosphere there is only a single authority, Fuchs, to the evident relief of Mr. Grimminger, who at once adopts his value of an increase to 1,900° K. at 420 km., but discards Fuchs's intermediate values in favour of again drawing a straight line from the N.A.C.A. figure for 120 km., although the latter really applies to middle latitudes. This is one example of many in which the author draws simple curves or lines on his graphs in order to simplify his calculations; he is usually justified because any resulting inaccuracy is far outweighed by the uncertainty of the original data. The same applies to the composition of ionospheric air, in which the chief uncertainty is the height at which oxygen molecules are dissociated into atoms by the Sun's ultra-violet light; this is vaguely believed to happen at about 100 km., so Grimminger assumes that dissociation starts at exactly 83 km. and is complete at 120 km.

From the detailed tables worked out by the author on all the foregoing assumptions, we see that, at a little above 300 km., atmospheric density is down to a ten-thousand-millionth of its sea-level value.

We now pass up through the F_2 layer from the region of uncertainty to that of sheer ignorance. The author collects all the bewildering possibilities into three groups, and works out tables for three corresponding "model" atmospheres.

Model I assumes that the atmosphere merges at its top into the interstellar gas, which might here be called "interplanetary gas." This gas, which pervades space, is believed to consist of about one hydrogen ion and one electron per cubic centimetre, with other elements in such small amounts as to be negligible in density calculations. Its density is about a thousand-trillionth (the 21st negative power of 10) of that of the atmosphere at sea level. Its temperature is believed to be between 10,000° and 15,000° K., and as the author finds such a high temperature awkward for various reasons, he arbitrarily adopts the lowest he dares, and calls it 10,000°.

In the interstellar gas, by the way, as in the upper reaches of the atmosphere, collisions between the gas particles are so infrequent that the word "temperature" merely expresses the kinetic energy of the individual particles; they are too few to affect appreciably the temperature of a body immersed in the gas.

The author, in calculating the properties of his Model I atmosphere, assumes for simplicity that it gets continually hotter from the F_2 layer up to its limit, where it is as hot as the interstellar gas; also that the F_2 layer rotates with the Earth and the interstellar gas does not, so that rotation speed diminishes with height. As to composition, he assumes that mean molecular weight falls off continuously with height, starting with a m.m.w. of 24 in an F_2 layer composed of dissociated oxygen and undissociated nitrogen.

He finds that, if the top of this atmosphere consisted of ionised hydrogen (*i.e.* ions plus electrons like the interstellar gas, with m.m.w. $= \frac{1}{2}$), its height would be 16,530 miles above sea level (26,600 km.) at the Equator. But he also works out the height for seven other possible compositions of the atmosphere at its limit (p. 67). This seems to the reviewer uncalled for, since the interstellar gas and the atmosphere must intermingle through a considerable depth, owing to the high speed and infrequent collisions of the gas particles, so there cannot be any sharp change of composition where they meet.

In any case, it makes little difference to the density what composition is assumed for the top of the atmosphere in Model I, as the author unexpectedly discovers after working out voluminous tables for various compositions.

In Atmospheric Model II account is taken of the fact that, in the very rarefied air above a certain height, the gas particles undergo so few collisions that they describe dynamical orbits, such as portions of ellipses, under the influence of gravity.

The author's treatment of this model seems the least satisfactory of the three. In the first place, he takes the temperatures of Model I up to the base of this "dynamical orbit region"; yet these temperatures are deduced from the properties of the interstellar gas, whereas Model II ignores the interstellar gas altogether and assumes that the top of the dynamical orbit region peters out into a vacuum. Then two other questions need explanation: why does the author assume this region to begin where the collison frequency is 1/10 (one collision per 10 seconds), and yet admit (p. 104) that a particle may spend up to 15 minutes in its dynamical orbit? Surely it would become too punch-drunk to follow such an orbit at all. And, secondly, why assume that this region has the same temperature at all heights, when each individual particle must slow down, *i.e.* get cooler, as it rises against gravity towards the top?

Model III is in many respects the most satisfactory of all. In this the author allows for "diffusive equilibrium": that is, in a region where there is no turbulent mixing, the atmospheric gases will separate out according to their weights, the lightest rising to the top. He reasons that this process begins about 100 km. above the F_2 layer; that is, at 400 km. in latitude 45° and at 500 km. over the Equator. Since nobody knows how much helium and hydrogen exists at this level, the author assumes the proportions to be the same as near the ground. Although the amounts are minute, they can spread through a considerable height in the rarefied atmosphere above 7,000 km., where hydrogen becomes the main constituent and helium has reached a maximum concentration of about 23 per cent.

As in Model II, the author assumes that the gas particles move in dynamical orbits above a certain level, which he calculates to be at 750 km. over the Equator and 650 km. in latitude 45°. And he still takes the dynamical orbit region to be at the same temperature throughout, adopting 2,500° K., a figure which he reaches after many pages of close theoretical discussion involving "excited" atomic states, photo-ionizing radiation, and other recondite processes.

Finally, the three models are compared; Model II is properly rejected, and Model III regarded as the most acceptable. The reviewer would agree, except that this model takes no account of the obvious necessity for an eventual merging with the interstellar gas, as in Model I. It is to be noted that at 70,000 km., the greatest altitude given in the author's tables for Model III, atmospheric density is still given as more than twenty times that of the interstellar gas. Here, though he has not noticed it, we are nearly a fifth of the way to the Moon, with density falling off ever more slowly with distance. Are the Earth and Moon, perhaps even the inner planets as well, all bathed in a common atmosphere many times as dense as the interstellar gas? Model III suggests that they are.

The main difficulty about accepting any of these models, as Grimminger explains, is their high temperatures in the upper regions; though he refuses, in a not very satisfactory paragraph on p. 123, to contemplate the possibility of temperatures falling off beyond the ionosphere. In Model I, for instance, the faster-moving of the atoms of oxygen and nitrogen would fly off into space; while any other model, assuming the accepted ionospheric temperatures, is open to objections voiced by W. Spitzer in a private communication to the author.

Spitzer argues that the temperature of the upper atmosphere of Mars must be about the same as that of the Earth, because (referring to the Sun's radiation): "the shape of the radiation intensity-frequency curve is more important than the absolute intensity of the radiation." Consequently, since the escape velocity for Mars is less than half that of the Earth, carbon and oxygen atoms would, at such temperatures, have escaped from its atmosphere long ago; yet they cannot have done so, because carbon dioxide is still present there. In brief, a hot Martian atmosphere is impossible and that of the Earth cannot be much hotter.

Grimminger points out that the *F* layer of the ionosphere may be cooler than we think, because we cannot deduce its exact temperature till we know its exact composition, a question which the RAND Corporation now proposes to tackle by analysing new data obtained during the war.

To sum up, there are reasons for doubting the high temperatures in all three atmospheric models. If we accept these reasons, the whole lot must go by the board and we are back again where we started from, no more than half-way up through the stratosphere.

As a possible get-out, Grimminger argues that, if all the higher atmosphere were ionised, the ions and electrons would be forced by the Earth's magnetic field to follow spiral paths and thus be hindered from escaping. But surely the spiral motion would be superimposed on the escape path: the only hindering effect would be, perhaps, a moderate increase in collision frequency.

It remains to be said that Mr. Grimminger has done a valiant job of work which needed doing. But there are signs that his sponsors have hurried him unduly by demanding quick results, and wasted his time by expecting a great splash of unnecessarily detailed tables of quite hypothetical data. Certainly this Report would have been much easier to follow if he had been given more time to digest those 108 references. A. E. S.

Rockets, Guns and Targets

(Edited by John E. Burchard, published by Little, Brown and Co., Boston, Mass., pp. 482, personnel index, subject index, $6.00.)

A series of books, "Science in World War II," which describes the activities of the Office of Scientific Research and Development (OSRD) includes a most interesting volume concerning the story of the military rocket. In fact, this book, *Rocket, Guns and Targets* is divided into three sections dealing with gun erosion, terminal ballistics, and solid-fuel military rockets, encompassing the activities of Divisions 1, 2, and 3 of the National Defence Research Council (NDRC).

Many people are apt to have the mistaken idea that the production of a new rocket or other technical weapon is accomplished by someone sitting down to be suddenly gifted with a flash of inspiration. The story told in this book indicates otherwise. It tells how men worked day and night racing against time to produce new weapons, testing countless materials, evolving empirical laws, predicting the performance of metals and fuel combinations, and finally, undertaking arduous field tests for periods of many months. It describes, too, the necessity for the development of new recording and testing instruments and techniques, and it places on record the continual opposition experienced from high placed officials who thought that they themselves knew all the answers and the scientists were wasting their time. This attitude was reflected in the uncertainty of the draft laws and the general shortage of trained scientists which resulted therefrom.

It is, indeed, interesting to read how many of the war-winning ideas would have been crushed by officialdom had it now been for the tenacity of purpose and confidence in success exhibited by a few stalwart individuals. The development of the frangible bullet is an excellent illustration of how pre-conceived ideas can so often be proved wrong if they are based on beliefs rather than on facts.

Also an absorbing story is that concerning the difficulties encountered in the production of large rocket grains. It is quite surprising to hear of sheet ballistite being so short in supply that certain experimental rocket projects had to be shelved and that waste pieces had so much value that the dry-extrusion presses were specially designed in order that waste could be re-used with the minimum amount of preparation.

Again, with hypervelocity guns and the reduction of gun erosion the hostility of accepted theory is apparent. Indeed, this book is another work which shows how most of Man's discoveries are made in the face of ridicule, if not open opposition, by people who should know better.

Perhaps a slight criticism may be levied against the numerous footnotes which tend to interrupt the reader by causing him to refer to masses of names and personal histories throughout almost the whole of the text. But, of course, the authors had a difficult job in placing on record, as well as they do, the details of all this immense amount of experimental work, together with its administrative background, with acknowledgments to all those scientists, civilian and military personnel who assisted or opposed its advance to fulfilment.

E. B.

The Science and Engineering of Nuclear Power—Vol. II

(Edited by Clark Goodman, 317 pp., figs. and index. Addison Wesley Press Inc. Cambridge 42, Mass., U.S.A. $7·50.)

The second volume of this work, like the first, is made up of a number of separate papers written by different authors. An attempt is made to cover a much wider field than in the earlier volume, with the result that many of the 17 papers, which make up the book, touch only lightly on the subjects under discussion.

The work opens, appropriately, with an account of the world's resources of

the raw materials of nuclear power; the ores of uranium and thorium and of various other substances such as boron, graphite, beryllium and cadmium, which are used in nuclear reactors. The available data seems to be mainly of pre-war origin, and it is doubtful whether the picture given is in anyway complete in view of the post-war reticence towards the publication of facts about some of these minerals. Some attempt has been made in this paper to assess the value of low grade uranium ores, by comparing the cost of power production if these ores are employed with the cost using coal. Here a great deal of latitude can arise in the estimates due to the uncertainty concerning the possibility of breeding, i.e. of replacing fissile material consumed by fresh fissile matter bred from ordinary uranium or thorium by absorption of the excess neutrons.

A paper on isotope separation is concerned mainly with the general theory of cascades. This is written without particular reference to any one type of separative element, but two sections are devoted by way of example, to separation by distillation and by centrifugation.

There are altogether, five chapters on various topics of pile theory. These, on the whole are rather specialized, dealing with such matters as lattices, albedo, pile kinetics and the measurements of important quantities such as diffusion length and thermal utilization. A paper on neutron physics research at Chalk River is, however, of more general interest, and contains an interesting account of the low-power heavy water pile, which was built in Canada by the British and Canadian group in 1945.

An article on heat transfer problems in nuclear reactors is much lengthier than one given previously in Volume I. Part of this is taken up by an almost word-for-word repeat of the earlier paper, the extra length being accounted for by more detailed considerations, such as heat removal from a reactor in which energy is not produced uniformly throughout the volume. There are short studies of heat removal from hypothetical reactors cooled by helium, water and liquid sodium and lead. One notes with some surprise on page 121, that the Fanning equation is given by $W = V_e \triangle p/J$.

Other subjects which are included in the work are: the shielding of nuclear reactors; effects of radiation on materials; production of radioactive isotopes; metallurgy of pile materials; health physics and future developments in nuclear energy. These are mostly brief accounts which are more likely to stimulate the readers' interest rather than to satisfy it. The chapter on health physics is particularly well written, dealing with biological effects of radiation, and the safety tolerances on various types of radiation. Several interesting facts are brought to light concerning genetic effects of radiation. One learns that no mutations have been observed in mammals despite irradiation over many generations. The observed spontaneous mutation rate in humans is about 150 times as great as that which would result from cosmic rays and other natural radioactivity at sea level, while an individual would need to receive 300 r. prior to child bearing to double the mutation rate.

The main interest of any B.I.S. member reading Vol. II is almost certain to fall on the conjectural account by Hsue-Shen-Tsien* of the application of

* This may be obtained as a separate paper, *cf.* J. Humphries, Abstracts.

nuclear energy to rocket propulsion. The nuclear powered rocket is visualized as employing a nuclear reactor to heat hydrogen up to a temperature of about 3,300° K. The author recognizes the need for fine subdivision of the reactor material in order to secure the immense heat transfer to the gas. The use of thin layers of porous graphite is suggested and it is shown that the pressure drop across such porous barriers would not be excessive. It is difficult to see why the author should have wasted time in computing the critical size of a reactor using U(235) = 0·1 U(238) instead of pure or nearly pure fissile material, since such a low enrichment necessarily adds expensive deadweight to the rocket. The reviewer is at a loss to explain the presence of a résumé of Ackeret's "Relativistic Rocket Theory" in this article. Until we have a method of more or less complete conversion of matter into energy, relativistic theory is irrelevant. The elementary fact that the velocities of fission fragments lie well below the "relativistic region" does not appear sufficient to deter certain writers from introducing Ackeret's theory into otherwise sensible papers on rocket propulsion.

There are further remarks on the application of nuclear energy to rockets in a final chapter by the editor of the series. This does not contain any new ideas, but introduces a rather quaint notion about the cooling of rocket motors.

It may be regarded as a shortcoming of this book, that most of the papers are little more than short essays. No doubt this will prevent Volume II from enjoying the position attained by the earlier volume as a reference book for nuclear engineers. However, this is an interesting work, which should appeal to the general scientific reader and the editor has certainly done well in the selection of papers giving an excellent picture of the wide field of science and technology which is involved in the application of nuclear energy.

L. R. S.

CORRESPONDENCE

Man and his Mark

SIR,

Mr. R. A. Smith's letter in your May issue raises no new question of principle, though it is possible that the comparative magnitudes of the factors involved (likely gains in our knowledge of the Moon and interplanetary travel as against likely damage to our satellite) differ more widely than on previous analogous occasions.

Because an experiment is dangerous not only to those directly concerned but also to other people (and things) with no immediate interest or connection, that is not necessarily a valid reason for abandoning the experiment. A great deal of speculation took place just before Rutherford succeeded in splitting an atomic nucleus, many people asserting that some sort of chain-reaction of ever increasing violence would be started, leading ultimately to the total destruction of the world. Similar speculations have from time to time been advanced (by reputable scientists) concerning some of the experiments either proposed or carried out with atomic weapons.

If we are never to undertake any experiment which *may* have disastrous

effects, I am afraid the progress of scientific investigation will be seriously hindered, and possibly entirely arrested.

Besides asking Mr. Smith to consider this general proposition concerning scientific experiment, I must protest most strongly against his use of the term "scientific hooliganism," and the implication that the scientists who plan to land an explosive missile on the Moon are all hooligans.

Any project such as this, perhaps fortunately, cannot be achieved without a very great deal of preparation, in the course of which eminent men in widely separated walks of life (scientific, administrative, and even political) will be required to give their approval.

These men are not all hooligans; many belong to the cream of our intellectual society, and are well used to weighing the balance of advantage and disadvantage in projects whose final outcomes may be unpredictable. They are not likely to permit any undertaking to proceed unless they are satisfied that all possible steps have been taken to ensure successful results with a minimum of danger, be it danger to themselves, to the human race generally, or to any possible inhabitants of other worlds or planets which may be concerned. The manner in which they have conducted tests of long-range rockets or atomic devices, with a minimum of danger to mankind and to our own planet, shows that far from being scientific hooligans, they have a very proper sense of their immense responsibilities.

Mr. Smith, as a scientist himself, ought not to need telling this.

Harpenden. BRUCE M. ADKINS.

Rocket Posts

Further to Mr. Carter's article "Rocket Posts" in the July Journal, *we have received an interesting letter from Tomas A. Terry of Havana, Cuba, regarding some experiments in his country which are claimed to have been the first* official *rocket mail in the world. Mr. Terry, who was personally concerned in the work, gives the following details*:—

"The rockets used were made by Professor A. V. Funes and measured 60 in. in length, were 6 in. in diameter at the widest point, and charged with 3 lbs. of powder. The total weight was 15 lbs., which included 5 lbs. of mail.

"The first trial flight on October 1, 1939, was unsatisfactory owing to a mistake in the charge and lack of stability, while on the second trial, which took place on October 3, the rocket covered a distance of over 800 m. A third trial followed on October 8, but the distance covered was then only 300 m. owing to strong head winds.

"The official experiments took place on October 15, in the shooting range of a sports club, before various civil and military authorities, including representatives of the Secretary of Communications.

"Two rockets were used for these trials, the first containing a package of 250 specially stamped letters. It flew for only a few metres, though the second and lighter rocket covered a distance of over 1,500 m. and returned to Earth by means of a parachute."

Astronomy and Astronautics

SIR,

There are two points which I should like to add to my paper which was read to the Society on April 2, 1949.

Since reading this lecture, the possibility that the Moon may have a tenuous atmosphere, suggested by indirect and rather uncertain evidence cited in my letter (*Journal B.I.S.*, *6*, 212, December, 1947), has received some confirmation by work done in Russia on the polarization of light received from the dark part of the Moon, when at quadrature.

This background illumination consists of three parts—

(*a*) light diffracted in the Earth's atmosphere;

(*b*) light reflected to the Moon from the daylight hemisphere of the Earth;

(*c*) light diffracted by a Lunar atmosphere (if one exists).

Component (*c*) should be polarized. The method of detection, while requiring extremely delicate observations, is much more sensitive than the determination of refraction at an occulation.

It is claimed that an atmosphere of a density 1/10,000th that of the Earth has been detected. It would seem that such a tenuous atmosphere should have little adverse effect on observations from the Moon, but it might serve as a useful protection against meteors. The reference is: Lipski, Y. N., *Dokl. Acad. Nauk SSSR*, *65* (No. 4) 465–8 (1949).

A further point (*see* page 180), is that while it is generally believed that the Zodiacal Light is due to extra-terrestrial particles, it is possible that the scattering particles are molecules in the "spray" region, very high up in the Earth's atmosphere (height 1,000 km.). This "spray" region is formed by atmospheric molecules shot up by impacts with other molecules in the denser regions below, into a region so tenuous that the molecules can describe large trajectories. If this is correct, the Moon should have no Zodiacal Light.

Cambridge. M. W. OVENDEN.

RECENT AND FORTHCOMING MEETINGS

September 24, 1949 (Saturday). "Rocket Propulsion and Interplanetary Flight," by A. V. Cleaver, to the South-Eastern Area, Society of Licensed Aircraft Engineers, Kingsway Hall, London.

October 21, 1949 (Friday). "Atomic Energy, the key to Astronomical Phenomena and Interplanetary Flight," by A. C. Clarke, to the World Forum for Science, Philosophy, and the Arts, at the Waldorf Hotel, W.C.2, 8 p.m.

October 26 (Wednesday). "Rocket Propulsion and Interplanetary Flight," by A. V. Cleaver, to the Gloucester and Cheltenham Branch of the R.Ae.S., Gloucester.

November 3, 1949 (Thursday). "Focus on the Moon," by E. Burgess, to Salford Photographic Society, Sandy Lane, Langworthy Road, Salford, Lancs., 8 p.m.

November 19, 1949 (Saturday). "A Symposium of Medical Problems Associated with Space Flight" (three papers). Various authors, to the Society at Caxton Hall, S.W.1, 6 p.m.

November 23, 1949 (Wednesday). "Interplanetary Flight," by A. C. Clarke, to the Rotary Club of Camberwell, Express Dairy Hall, 43, Peckham High Street, S.E.15, 1.40 p.m.

November 26, 1949 (Saturday). "Other Planets, Their Physical Conditions and Possibilities of Life," by J. C. Farrer, F.R.A.S., President of the Manchester Astronomical Society, to the North-West Branch at Adult Education Institute, 49, Lower Mosley Street, Manchester, 2, at 6.30 p.m.

November 30, 1949 (Wednesday). "Into Space," by E. Burgess, to Manchester Arts Club, Mid-day Studios, Mosley Street, Manchester 1, Lancs, 7 p.m.

November 30, 1949 (Wednesday). "Rocket Propulsion and Interplanetary Flight," by A. V. Cleaver, to Oxford University Scientific Club, Clarendon Laboratory, Oxford, 8.15 p.m.

December 3, 1949 (Saturday). Film Show to members of the Society, at the Science Museum Lecture Theatre, S.W.7. Admission by ticket only, obtainable from the Secretary. Commencing at 6 p.m.

December 9, 1949 (Friday). The Society's Fourth Annual General Meeting, at St. Martin's School, Charing Cross Road, W.C.2, 6 p.m.

December 20, 1949 (Tuesday). "Ionospheric Research at White Sands," by E. Burgess, to Manchester Astronomical Society, Reynold's Hall, College of Technology, Sackville Street, Manchester, Lancs., 7 p.m.

OFFERED: *L'Astronautique* (*Compl.*), by R. Esnault Pelterie, 7s., new copy. Also various periodicals containing articles on rockets and allied subjects. Will also exchange.—G. de Koningh, 18, v.d. Brugghenstraat, Delft, Holland.

THE BRITISH ASTRONOMICAL ASSOCIATION

Founded 1890, now numbers 2,000 members. Open to all interested in Astronomy. Chief objects are the association of observers for mutual help, circulation of astronomical information, and encouragement of popular interest in Astronomy. The Association issues a *Journal* about nine times annually, *Circulars* giving current Astronomical news, and *Memoirs* on the work of Sections, including the Sun, Planets, Comets, Auroræ, and Variable Star Sections.

The Association has a good Lending Library and Lantern Slide Collection. A number of instruments are also available for loan to members.

For further particulars apply to—

The Assistant Secretary, 303, Bath Road, Hounslow West, Middlesex.

BOOKS on PURE AND APPLIED SCIENCE ALWAYS AVAILABLE

Please state interests when writing.

H. K. LEWIS & Co. LTD. 136 GOWER STREET, LONDON, W.C.1.

Established 1844. *Telephone: EUSton 4282 (5 lines).*

Sky and TELESCOPE

ASTRONOMY FOR EVERYONE

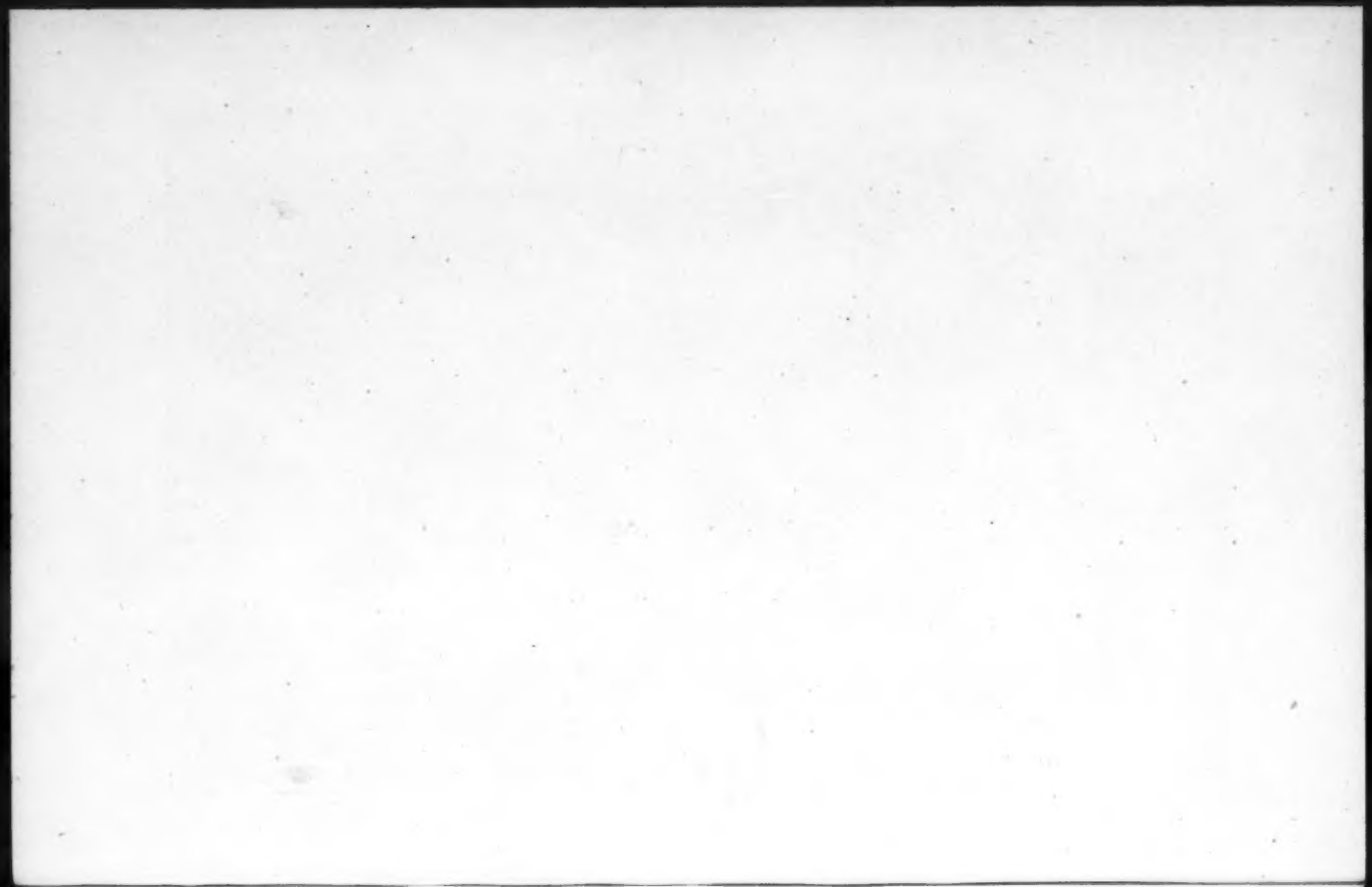
A popular illustrated monthly on astronomy and related sciences.

Star charts for all the sky; observer's page; telescope-making department; news notes; amateur astronomer's page. latest advances in astronomy.

Subscription: $4.00 worldwide; $3.50 in Canada and Pan-American Union; $3.00 in United States. Sample copy sent on request.

SKY PUBLISHING CORPORATION, Harvard Observatory, Cambridge 38, Mass., U.S.A.

PRINTED BY W. HEFFER & SONS LTD., CAMBRIDGE, ENGLAND



AN INTERESTED GROUP DISCUSSES INTERPLANETARY FLIGHT.

This photograph was taken at a meeting of the International Language Club, East Croydon, in January, 1949—one of the many "outside" lectures undertaken during the year.

Annual Report

of the

British Interplanetary Society

(Limited by Guarantee)

FOURTH ANNUAL GENERAL MEETING

NOTICE IS HEREBY GIVEN that the FOURTH ANNUAL GENERAL MEETING of the BRITISH INTERPLANETARY SOCIETY will be held at St. Martin's School of Art, 107, Charing Cross Road, London, W.C.2, on **Friday, the 9th day of December, 1949,** at **6** o'clock in the evening precisely, for the transaction of the business specified in the Agenda below.

AGENDA

1. To receive the annual statement of accounts and balance sheet and the auditor's report thereon.

2. To hear the Chairman's speech.

3. To elect four Members of the Council of the Society. In accordance with the provisions of Article 15 the following existing Members of the Council will retire at that meeting.

A. V. Cleaver.	K. W. Gatland.
T. R. F. Nonweiler.	G. V. E. Thompson.

of these, Messrs. Cleaver, Gatland, and Thompson, being eligible, offer themselves for re-election.

The following additional names have also been nominated:—

F. R. Fears	*Member.*
W. H. Gillings	*Member.*
A. M. Kunesch	*Member.*
W. N. Neat	*Fellow.*
M. W. Wholey	*Fellow.*

Since the number of nominations exceeds the number of vacancies, election will be by postal ballot. The necessary ballot papers are enclosed with this agenda.

4. Any other business.

By order of the Council,

L. J. CARTER,

Secretary.

SYLLABUS OF ADDRESSES DELIVERED TO THE LONDON MEETINGS OF THE SOCIETY DURING THE SESSION 1948-49

Saturday, 9th October, 1948

"Interplanetary Man?" In the opening lecture of the session, Dr. Olaf Stapledon discussed the profound ethical, philosophical and religious questions which will undoubtedly arise from interplanetary exploration. The possibility of finding intelligent life on other worlds, the colonisation of planets, interstellar communication, and the possibility of telepathic communication were also considered. The paper was published in full, together with an abstract of the resulting discussion, in the *Journal* of the Society, Vol. 7, No. 6, November, 1948.

182 members and visitors were present.

Saturday, 13th November, 1948

"Orbital Bases," by H. E. Ross. This lecture dealt with the uses and possibilities of instrument-bearing and manned spacestations. The problems associated with initiating and maintaining these objects were also outlined, and the lecture concluded with a description of a comprehensively equipped spacestation designed in co-operation with Mr. R. A. Smith. The paper was reproduced in full in the *Journal* of the Society, Vol. 8, No. 1, January, 1949.

90 members and visitors were present.

Saturday, 11th December, 1948

"The Problem of Interplanetary Flight" (Part I). This was the first of two meetings which surveyed the difficulties which must be overcome to make possible manned flight from the Earth to the Moon and planets, with particular reference to the possibilities and limitations in applying atomic energy. The first meeting was divided into two papers:—

(*a*) *The Dynamics of Space-Flight*, by A. C. Clarke, B.Sc., which dealt with such matters as the exhaust velocity and mass-ratio requirements of interplanetary rockets. This paper was reproduced in the *Journal*, Vol. 8, No. 2, March, 1949.

(*b*) *Limitations of the Chemical Rocket*, by A. V. Cleaver, which dealt with the difficulties which will be met in attempting to develop rockets with the performances specified by the previous speaker.

98 members and visitors were present.

Saturday, 15th January, 1949

"The Problem of Interplanetary Flight" (Part 2). The second part of this meeting began with a paper *The Application of Nuclear Energy*, by L. R.

Shepherd, B.Sc., A.Inst.P., which dealt with the possibility of applying nuclear energy to reaction propulsion units, and this was followed by a *Summary* of all the papers by A. V. Cleaver, after which the matter of both evenings was thrown open to general discussion.

The subject matter of the papers of Mr. Cleaver and Mr. Shepherd on both evenings appeared in *The Atomic Rocket*, which was published in four parts in the *Journal*, Vol. 7, Nos. 5 and 6, and Vol. 8, Nos. 1 and 2 (i.e. September and November, 1947, and January and March, 1948).

88 members and visitors were present.

Saturday, 12th February, 1949

"The Design of Rocket Motors," by J. Humphries, B.Sc. (Eng.), A.F.R.Ae.S. A.M.I.Mech.E., which outlined the methods employed in the design of liquid-propellant rocket motors, including choice of propellants, choice of propellant expulsion system, combustion chamber design, and methods of testing. This paper was reproduced in the *Journal*, Vol. 8, No. 3, May, 1949.

62 members and visitors were present.

Saturday, 12th March, 1949

"A Review of Progress in Astronautics Since the War," by A. V. Cleaver. Up to 1939 the achievement of interplanetary travel appeared to belong to the remote future, but with the War came tremendous progress in the application of rocket propulsion to aircraft and guided missiles, the release of atomic energy, and in other related scientific fields. Mr. Cleaver reviewed the situation in the light that all this research, conducted for more immediate aims, would materially contribute to progress in Astronautics. A summary of this lecture appeared in the *Journal*, Vol 8, No. 4, July, 1949

94 members and visitors were present.

Saturday, 2nd April, 1949

"Astronautics and Astronomy," by M. W. Ovenden, B.Sc., F.R.A.S., which attempted to forecast the many important contributions which present and future developments in the field of interplanetary travel are likely to make to the advancement of astronomical research.

This paper was reproduced in the *Journal*, Vol. 8, No. 5, September, 1949.

77 members and visitors were present.

Saturday, 16th July, 1949

By courtesy of the Ministry of Supply, a special showing of the German film *History of Rocket Development*, was given to Fellows of the Society at the War Office. A review of the film appeared in the *Journal*, Vol. 8, No. 6, November, 1949.

34 Fellows were present.

SYLLABUS OF ACTIVITIES OF THE NORTH-WESTERN DISTRICT CENTRE DURING THE SESSION, 1948-49

Saturday, 22nd January, 1949

"Spacestations" by E. Burgess, which outlined the theory of artificial satellites, stability of their orbits, mass-ratios involved and the uses and possibilities of the 24 hours orbital rocket.

21 members and visitors were present.

Wednesday, 9th March, 1949

Visit to Godlee Observatory, Manchester. With fine atmospheric conditions, members were able to use the 8-inch refractor to explore the Moon, Saturn, the Orion Nebula, etc. Interesting subjects were pointed out, and a short talk given on the instruments at the Observatory. Astronomical photography was also discussed.

17 members and visitors were present.

Saturday, 23rd April, 1949

By courtesy of the Ministry of Supply, the following two films were shown.

(*a*) Rocket Flight.

(*b*) Airborne Rockets (technicolor).

These films lasted for just over two hours. The audience were also able to see a small exhibition of photographs of German guided missiles, a selection of astronomical pictures, and a 1/24th scale model of a V2.

261 members and visitors were present.

LIST OF SOCIETIES INTERESTED IN SPACE-FLIGHT

American Rocket Society, Engineering Societies Building, 29, West 39th Street, New York, N.Y., U.S.A.

Canadian Rocket Society, 9, Wood Avenue, Toronto 12, Ontario, Canada.

Danish Society for Space-travel Research, 27, Aabakkevej, Copenhagen, Denmark.

Detroit Rocket Society, 682, South Waterman Avenue, Detroit 17, Michigan, U.S.A.

Gesellschaft für Weltraumforschung, e.V., Zuffenhausen, Reistr. 16, Stuttgart-O den, Germany.

Groupement Astronautique Français, 37, rue Lafayette, Paris, France.

Nordwestdeutsche Gesellschaft für Weltraumforschung e.V., (24b), Friedrichstadt (Eider), Postfach 2, Germany.

Pacific Rocket Society, 1130, Fair Oaks Avenue, South Pasadena, California, U.S.A.

Reaction Research Society, 3262, Castera Avenue, Glendale, 8, California, U.S.A.

Sociedad Argentina Inter-Planetaria, C. Pellegrini 651, Buenos Aires, Argentina, S. America.

Sudwestdeutsche Gesellschaft für Weltraumforschung e.V., 77, Falkstrasse, Frankfurt am Main-West, Germany.

United States Rocket Society, 469 Duane Street, Glen Ellyn, Illinois, U.S.A.

Vereinigte Astronautische Arbeitsgeweinschaften (10b), Leipzig O5, Untere Muensterstr. 27, Germany—Russian Zone.

FOURTH ANNUAL GENERAL MEETING

(For the convenience of those members unable to be present at the meeting, the Chairman's Address is given below.)

CHAIRMAN'S ADDRESS

GENTLEMEN,

This Fourth Annual General Meeting of the post-war British Interplanetary Society is the second such occasion on which I have had the pleasure of addressing you, and I feel that I may justifiably repeat the substance of my opening remarks last year.

The 1948–49 session has been another very successful one, and once again we can therefore look forward into the coming year with confidence that our Society will continue to grow in both membership and status. Such a result is assured, given the continued support of the members and the hard work of all those concerned in running the affairs of the Society. I am sure that the Council for 1950 will be no less active than the one for the past year, to whose loyalty and efforts I now wish to pay tribute as their Chairman. Once again, I particularly want to assume the privilege of thanking, on behalf of the whole Society, Mr. L. J. Carter for his unremitting labours as Secretary throughout the year now under review.

In support of these general observations, I shall now present for your approval the detailed report of the Council for the period 1st October, 1948, to 30th September, 1949, both dates inclusive.

Membership

At the end of the 1948–49 session, the membership totalled 577, comprising 6 Honorary Fellows, 177 Fellows, and 394 Members. This represents an increase of 75 over the total for 1948 and is particularly gratifying when it is remembered that the increase this year is even larger than the figure of 58 which we were able to report at the previous Annual General Meeting.

Once again I would remind you of our need to continue with this satisfying trend. The Secretary will always be pleased to send particulars of the Society and specimen journals to the friends of members, whose continued assistance in making our numbers grow is hereby solicited.

On the subject of our new Honorary Fellows, I feel I should say some few words of explanation, and at the same time welcome them into our ranks. In the case of every one of them, we are proud that they have accepted our invitation and so conveyed to our Society an honour equal to that which we wished to confer upon them.

The post-war Constitution of the Society gave us the right to create Honorary Fellows from 1945 onwards, but it was only during the past year that we considered ourselves sufficiently well-established to take this step. Our new Bye-laws (of which I shall have more to say later) provide that the number of Honorary Fellows shall be restricted to ten, with the object of preserving the dignity and value of this special grade of membership.

Our first Honorary Fellow was Professor Hermann Oberth, the great pioneer whose work needs no comment from me. Our second was Mr. P. E. Cleator, who founded the B.I.S. in 1933 and—largely through his book, *Rockets Through Space*—was instrumental in starting a significant asronautical movement in this country; I can think of no better qualification for Honorary Fellowship of this British Society.

We also succeeded in making contact with four other men whose contributions have placed them in the very front rank of pioneers in rocketry and space flight, and they also have accepted our invitations to Honorary Fellowship. Their names are:—

Prof. Dr. Wernher von Braun.
M. Robert Esnault-Pelterie.
Ing. Guido von Pirquet.
Dr. Eugen Sänger.

Once again, I have to say that the achievements of these men render superfluous any remarks from myself; in any case, full details of their careers will appear in our *Journal*.

It is perhaps fitting on this occasion that we should remember also those other pioneers in our subject whose death has prevented the Society from ever attempting to confer comparable recognition upon them. In particular, it is a matter of the deepest regret that we were unable to extend such an invitation to the great American, Dr. Robert H. Goddard (1882–1945). In addition, Dr. Hohmann was killed in an air raid during 1945, Dr. Winkler died in 1947, and the Russian, Ziolkovsky—who was the earliest of all scientific workers in the astronautical field—in 1936. The passing of these originators is a reminder that the interplanetary idea now has a considerable technical background in time, but comparable qualities will be required in future pioneers if our ambitions are to be realised.

Publications

During the year, the Society has issued the following publications:—

(*a*) Six *Journals*: Vol. 7, No. 6 (for November, 1948), and Vol. 8, Nos. 1 to 5 inclusive (for January, March, May, July and September, 1949).

(*b*) The Annual Report and List of Members for 1948, in the November of that year.

(*c*) A revised second printing of the Book List in September, 1949. It is intended to keep this up-to-date and members can always obtain further copies on request.

We still follow the practice of printing 1,500 copies of our *Journal*, which circulates among a large number of individuals and institutions, as well as to our membership. Under our exchange agreement with the American and Pacific Rocket Societies, the following further publications have been sent to Fellows (and to Members in rotation, as far as stocks have permitted):—

A.R.S. *Journals*: Nos. 75, 76 and 77.
Pacific Rockets: Vol. 3, Nos. 1 and 2 (combined issue) and No. 3.

In the past year, we have endeavoured to improve our information service to members through the medium of book reviews, abstracts, and general comment on items appearing in the world's press. Any help which members could themselves provide, in increasing the scope of this coverage, would be appreciated by the Publications Committee.

Meetings

The Society has held seven general meetings during the year, at all of which lectures were delivered. In addition, a special film show for Fellows was held at the War Office Cinema, Whitehall, by courtesy of the Ministry of Supply. Further details of these meetings are recorded elsewhere in the printed Annual Report, and comparison with the similar records for last year will reveal a welcome further increase in the attendances.

This increased attendance necessitated a search for a new meeting place for the Society, as the room most frequently available at St. Martin's School of Art had become inadequate and the larger hall there was not regularly obtainable. Hence, although all the 1948–49 meetings were held at St. Martin's, for the coming year lectures will be held in the Tudor Room at Caxton Hall.

There have also been eleven meetings of your Council to conduct the business of the Society, and three meetings of the Technical Committee.

It will be noticed that the list of the Society's activities for the past year also includes mention of a lecture, a visit, and a highly successful film show, organised by our North-West District Centre under the leadership of Mr. Eric Burgess, a Member of Council. This sign of increased activity in the provinces is very much welcomed by the London headquarters of the Society, and we are confident that even more will be achieved next year. All possible help and encouragement will be given to any such attempts to spread the activities of the Society further afield than the London area.

Into this same category of attempting to cover a wider geographical field (though in a different way), there falls the question of the numerous occasions on which the Society is asked to provide lectures for other bodies, often situated at a considerable distance from London. During the past year, no less than 28 such lectures on rocket propulsion and interplanetary flight have been given. In all cases, the burden of this work has been carried by one or other of some five Council Members, and latterly we have been forced, with great regret, to decline some invitations. If any members, especially in the provinces, would be prepared to volunteer their services as lecturers, the Council would be very glad to consider such cases; slides and necessary data could be provided on request.

Library

While it has still not proved possible to house the library at some central address, facilitating reference and the initiation of a lending service, it is

nevertheless gratifying to be able to record that our collection of books continues to grow very satisfactorily. Additions are made by purchase, the acquisition of review copies, and by donations.

In this latter connection, mention must be made of the presentation of a magnificent collection of rare and valuable astronautical works made by one of our new Honorary Fellows, M. Esnault-Pelterie. Our gratitude to him for this generous action is hard to express adequately, and is similarly due to Dr. Sänger for his donation of several copies of his own original works and papers. The literature in question is summarised below:—

Received from M. Esnault-Pelterie

Title	*Author*	*Date of Publication*
L' Astronautique (two copies)	R. Esnault-Pelterie	1930
Vie et Travaux scientifiques	R. Esnault-Pelterie	1931
L'Astronautique complément (two copies)	R. Esnault-Pelterie	1935
Notice sur les Travaux scientifiques	R. Esnault-Pelterie	1936
De la Bombe atomique à l'Astronautique (four copies)	R. Esnault-Pelterie	1946
Die Rakete zu den Planetenräumen	Herman Oberth	1925
Die Erreichbarkeit der Himmelskörper (two copies)	W. Hohmann	1925
Die Fahrt ins Weltall	Willy Ley	1926
Die Rakete	Johannes Winkler	1927
Die Rakete	Johannes Winkler	1928
Die Möglichkeit der Weltraumfahrt	Willy Ley	1928
Raketenfahrt	Max Valier	1928
Die Rakete	Johannes Winkler	1929
Wege zur Raumschiffahrt (two copies)	Hermann Oberth	1929
Die Rakete für Fahrt und Flug	A. B. Scherschevsky	1929
Das Weltraum-Recht	Wladimir Mandl	1932
Männer der Rakete (twio copies)	Werner Brügel	1933
Raketenflugtechnik (two copies)	Eugen Sänger	1933
Die Rakete zur Höhenforschung	Vladimir Mandl	1934
La Nature et les Hommes	N. A. Rynin	1928
Le Navire cosmique	N. A. Rynin	1928
Superaviation et Superartillerie	N. A. Rynin	1929
Les Fusées	N. A. Rynin	1929
Théorie de la propulsion par réaction	N. A. Rynin	1929
Astro-Navigation (two copies)	N. A. Rynin	1932
K. E. Ziolkovski, sa vie, son oeuvre et les fusées	N. A. Rynin	1931
L'Energie rayonnante	N. A. Rynin	1931
Théorie de l'essor cosmique	N. A. Rynin	1932
Initiation à la Cosmonautique	Ary J. Sternfeld	1937

Received from Dr. Sänger

Deutsche Forschungsanstalt für Segelflug E. V. "Ernst Udet," z. Zt. Ainring No. 3538	E. Sänger and J. Bredt	1944
Ditto No. 3536 (two copies)	E. Sänger	
Neuere Ergebnisse der Raketenflugtechnik (two copies)	E. Sänger	1934
Les principes fondamentaux des avions à stato-réacteur Lorin	E. Sänger	1947
Der Verbrennungs-Raketenmotor (two copies)	E. Sänger	1936
Statoréacteurs et Vitesses Supersoniques	E. Sänger	1949

It is, of course, still our hope that it will be possible to make the library available to members in due course for reference and the borrowing of books. Already there is in existence (under the administration of Mr. J. Humphries) a service for the post-free borrowing of photostat copies of interesting articles, etc., and members interested in this may obtain a list of the photostats available on making application to him, at 97, Churchill Avenue, Southcourt, Aylesbury, Bucks.

Technical Advisory Committee

Following the re-organisation described in last year's Annual Report, this Committee has continued to meet under the chairmanship of Mr. L. R. Shepherd. A programme of construction of models has been drawn up, and also a series of theoretical investigations into relevant problems of thermodynamics, dynamics, heat transfer and structures, concerned with space flight.

All this work is still in progress, but members will in due course see its results, at our future meetings, and in our *Journal*.

Broadcasting

As evidence of the growing interest in interplanetary matters amongst the world at large, it seems worthwhile to record here that during the past year the following radio talks have been heard over the services of the British Broadcasting Corporation.

On 25th January, "Spaceships," by Mr. Charles Gibbs-Smith—who subsequently joined our Society.

On 29th May, "Rocket Development," by Mr. K. W. Gatland (a member of Council).

In July, "Is there Life Elsewhere in the Universe?" by Messrs. Hoyle and C. D. Darlington (reprinted in *The Listener* for 21st July, 1949).

In addition, a number of talks over the South African radio service have been given by Mr. Cleator, the founder of this Society, who has recently travelled to that country on an extended visit.

Accounts

On this vital subject, the important point to make is that we have again succeeded in balancing our budget. It remains true that the Society could

benefit considerably from an increased income, but I hope and believe that you will feel we have made good use of what we have. If that is so, then perhaps some of you may be prepared to respond to my renewed appeal for donations; money received by the Society in this way, at the present stage in its development is exceedingly useful in enabling us to expand our activities. During the past year, you will notice that a sum of £65 was donated to our funds.

The cost of publications has again increased over the previous year, but this is part of our deliberate policy to improve the size and contents of the *Journal* whenever possible.

A new item in the accounts which perhaps calls for some explanation is the "Subscription Reserve." As the subscription year ends on 31st December, while the financial year ends on 30th September, we have decided to transfer a proportion of the annual subscriptions to this reserve account, in order to defray expenses for the remainder of the year, i.e. between 1st October and 31st December, after which latter date the new subscription year commences. This action represents a most desirable step towards strengthening our general financial resources and stability.

This seems a convenient occasion to remind members that it would save the Secretary much clerical work if they could pay their subscriptions by Bankers' Order. Subscription reminders may then safely be ignored. In the future receipts will not be issued for payment by Bankers' Order, unless specially requested, as they are rendered superfluous by this form of payment.

Your attention is also drawn to the scale of Compounded Life Subscriptions to the Society, which has now been agreed by Council as follows:—

Age limits	*Membership*	*Fellowship*
	£	£
20–25	25	35
26–30	23	32
31–35	21	30
36–40	18	26
41–50	16	22
51–	14	18

A number of such compounded subscriptions have been received, and the monies so obtained have been set aside to provide a capital fund for the future purchase of any necessary equipment, etc. An example of a case where use might have been made of these finances occurred during the past year. The imminent change in the Society's meeting place, from St. Martin's to Caxton Hall, necessitated the purchase of our own projectors for slides and film strips.

In this particular case, however, it proved unnecessary to touch the capital fund. Mr. P. E. Cleator, on the eve of his departure for South Africa, very generously offered to donate an equal sum to that given by all the other Council Members together, towards this item. A total of £38 was subscribed in this way, which was a sufficient contribution for the balance to be met from current income.

Articles of Association and Bye-laws

It was our intention to include in this printed Annual Report the full list of revised Articles, as approved by last year's Annual General Meeting. During the year, however, the Council have compiled a complete set of Bye-laws, governing the conduct of the Society in accordance with the new Articles, as laid down in Article 22. These Bye-laws were drafted by a Committee consisting of myself, the Secretary, and Mr. Brian Algar, a legal member whose assistance is hereby gratefully acknowledged. They were approved by the Council at their September, 1949 meeting.

It was therefore decided to prepare a printed booklet containing both the Articles and the Bye-laws. This will be issued within the next few months to all present members, and will also be sent to all future members, so that it will be available on all occasions as a convenient source of reference on any matters relating to the Constitution of the Society and the conduct of its affairs.

Council

This is the first year on which our Council elections have to be conducted in accordance with the provisions of the new Article 15, as passed by the 1948 Annual General Meeting. This requires that one-third of the current Council shall retire each year, so creating, for this year, four vacancies.

The Council Members who have retired in accordance with the above requirements are: myself, Mr. K. W. Gatland, Mr. T. R. F. Nonweiler and Mr. G. V. E. Thompson.

Of these, Messrs. Gatland, Thompson and myself have, being eligible, offered ourselves for re-election if you so desire. Elsewhere in this printed report, there are listed the names of the other nominations to Council received, and voting forms for a postal ballot have been sent to all members. Following the discussion and, I hope, formal approval of this report of the work of the 1948–49 Council, we shall proceed to announce the names of those elected to serve in the coming year. It is my confident belief, as I have already said, that this new year of activity for the British Interplanetary Society will bring further success and progress towards our avowed objectives.

A. V. CLEAVER,

9th December, 1949. *Chairman of the Council.*

CHANGES OF ADDRESS, ETC.

Members are requested to inform the Secretary if there are any changes or alterations which should be made to the Society's list of addresses and qualifications in order to keep the records up to date. This should be done by means of a *postcard*, as it is not sufficient to write from a new address without specifically drawing attention to the fact.

The Branch Secretary should also be notified by those members who take part in the activities of the North-Western District Centre.

The British Interplanetary Society

(Limited by Guarantee)

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1948.

30th Sept., 1948.	EXPENDITURE.	£ s. d.	£ s. d.
	To Management Expenses—		
53 14 2	Printing and Stationery	43 13 3	
49 16 8	Postage, Telegrams and Telephone	90 12 1	
10 13 2	Publicity and Advertising	28 17 11	
1 19 6	Library Expenses ..	4 4 0	
2 9 8	Bank Charges and Exchange..	3 11 2	
2 1 6	Clerical Assistance ..	5 4 9	
– – –	Travelling and Entertaining	8 1 8	
3 18 9	Sundry Expenses ..	18 2 2	
			202 7 0
124 13 5			
8 8 0	„ **Accountancy and Audit**		8 8 0
	„ **Publications—**		
530 1 11	Journal	639 9 5	
54 3 6	1948 Annual Report ..	57 4 6	
10 5 0	Book List	4 0 0	
			700 13 11
594 10 5			
21 17 9	„ **Expenses of Meetings—**		
	London	39 19 10	
	Manchester	5 3 0	
			45 2 10
	„ **Depreciation—**		
7 19 0	Fixtures and Fittings ..	15 5 6	
10 18 6	Library	22 1 5	
			37 6 11
18 17 6			
– – –	„ **Subscription Reserve** ..		80 0 0
	„ **Balance of Income over Expenditure,** carried to		
83 10 2	Accumulated Fund ..		7 1
851 17 3			1,074 5 9

30th Sept., 1948.	INCOME	£ s. d.
654 17 0	**By Membership Subscriptions**	803 19 0
34 15 0	„ **Entrance Fees**	37 15 0
36 18 3	„ **Donations**	65 2 5
– – –	„ **Special Donation** to cost of Projectors	38 0 0
125 7 0	„ **Sundry Receipts**	129 9 4
851 17 3		1,074 5 9

BALANCE SHEET as at 30th September, 1949.

BALANCE SHEET as at 30th September, 1949.

30th Sept., 1948.							*30th Sept., 1948.*						
£	s.	d.	*Capital Reserves.*	£	s.	d.	£	s.	d.	*Fixed Assets.*	£	s.	d.	£	s.	d.
			Accumulated Fund as at 30th							**Fixtures and Fittings—**						
115	*0*	*1*	September, 1948	198	10	3				At cost as at 30th September,						
			Add Excess of Income over				*54*	*12*	*0*	1948..	87	2	0			
			Expenditure for the year to				*32*	*10*	*0*	Additions during year at cost	65	7	6			
83	*10*	*2*	30th September, 1949 ..		7	1										
							87	*2*	*0*		152	9	6			
198	*10*	*3*					*15*	*7*	*0*	*Less* Depreciation to date ..	30	12	6			
			Compounded Subscription				*71*	*15*	*0*					121	17	0
—			**Reserve**			86	0	0		**Library—**						
—			**Subscriptions Reserve**			80	0	0	*55*	*8*	*0*	At cost as at 30th September,						
										1948..	71	1	0			
			Total Reserves ..			364	17	4	*15*	*13*	*0*	Additions during year at cost	39	4	11			
			Current Liabilities.													
11	*13*	*3*	**Subscriptions paid in Advance**	18	5	3	*71*	*1*	*0*		110	5	11			
17	*8*	*0*	**Sundry Creditors**	133	6	0	*27*	*6*	*6*	*Less* Depreciation to date ..	49	7	11			
29	*1*	*3*				151	11	3						60	18	0
							43	*14*	*3*	Total Fixed Assets ..				182	15	0
										Current Assets.						
							9	*0*	*0*	**Sundry Debtors**	20	9	4			
							1	*11*	*0*	**Subscriptions in Arrears** ..	10	19	6			
							5	*13*	*5*	**Payments made in Advance**	21	11	0			
							—			**Compounded Subscription**						
										Deposit Account	86	0	0			
							95	*2*	*10*	**Cash at Bank**	194	13	6			
								14	*9*	**Cash in Hand**	—	—	3			
							112	*2*	*0*					333	13	7
227	*11*	*6*				516	8	7	*227*	*11*	*6*			516	8	7

Certified to be a true copy—

A. V. CLEAVER } *Members of the*
A. C. CLARKE } *Council.*

L. J. CARTER, *Secretary.*

REPORT OF THE AUDITOR TO THE MEMBERS OF THE BRITISH INTERPLANETARY SOCIETY

I have obtained all the information and explanations which to the best of my knowledge and belief were necessary for the purposes of my audit. In my opinion proper books of account have been kept by the Society so far as appears from my examination of those books. I have examined the above Balance Sheet and annexed Income and Expenditure Account which are in agreement with the books of account. In my opinion and to the best of my information and according to the explanations given to me, the said accounts give the information required by the Companies Act, 1948, in the manner so required, and the Balance Sheet gives a true and fair view of the state of the Society's affairs as at 30th September, 1949, and the Income and Expenditure Account gives a true and fair view of the surplus of income over expenditure for the year ended on that date.

35, Brian Avenue,
Sanderstead, Surrey.

16th November, 1949.

T. W. WOODS,
Incorporated Accountant.

LIST OF MEMBERS
of
The BRITISH INTERPLANETARY SOCIETY

Membership numbers and classes are indicated against the names, which are arranged alphabetically in this list.

A

188. ABEL, Richard Cox, *A.F.R.Ae.S.* — FELLOW
Tiltman Langley Laboratories, Ltd., Redhill Aerodrome, Surrey.

436. ADKINS, Bruce Maxwell — FELLOW
Bowers Close, Bowers Way, Harpenden, Herts.

512. AISTON, Alfred Colin — MEMBER
8, James Street, Scarborough, Yorks.

568. ALDERSMITH, F/O. Michael Frederick — MEMBER
Officer's Mess, R.A.F., Koggala, Habaraduwa, Ceylon.

23. ALGAR, Brian, *LL.B.* — MEMBER
5, Ambleside Avenue, Toller Lane, Bradford, Yorks.

82. ALLEN, D. C. — MEMBER
Kennelwood Mews, French Horn Lane, Hatfield, Herts.

342. ALLEN, Dennis William — MEMBER
1, Poltimore Road, Guildford, Surrey.

687. ALLEN, Richard Clive — MEMBER
282, Warley Road, Smethwick, 41, Staffs.

488. ALLEN, Sidney, *A.M.I.Mech.E.* — FELLOW
30, The Park Paling, Cheylesmore, Coventry.

142. ALLISON, J. H. G. — MEMBER
47, Long Lane, Blackheath, Birmingham, Warwicks.

381. ALLPORT, Kenneth George — FELLOW
171, Red Lion Road, Surbiton, Surrey.

195. ALLWARD, Maurice Frank — MEMBER
19, Hamlet Road, Upper Norwood, S.E.19.

624. AMBLER, Frank Murray — MEMBER
c/o Miss Murray, Fort Monghyr, E.I.R. Behar, India

526. AMIES, Peter Norman — MEMBER
4, The Circle, Cricklewood, N.W.2.

633. ANANOFF, Alexandre — MEMBER
5, Av. Mozart, Paris XVI°, France.

727. ANDREW, Earle James — MEMBER
240, Churchill Avenue, Ottawa, Ontario, Canada.

173. APPLEBY, Frank Ernest — MEMBER
28A, Chester Way, Kennington, S.E.11.

391. APPLEBY, Stephen Villiers — MEMBER
Flat 2, 23, Conduit Street, W.1.

241. APPLEYARD, Albert Henry — MEMBER
77, Greenleafe Drive, Ilford, Essex.

80. ARMANDIAS, Louis S. — FELLOW
Woodholme, Parsonage Lane, Farnham Royal, Bucks.

554. ARTHUR, John David — MEMBER
"Waysmeet," Epsom Road, Ewell, Surrey.

169. ASHFIELD, Sidney George Norman — MEMBER
27, Woodland Road, Thornton Heath, Surrey.

388. ASHTON, Dennis, *Grad.R.Ae.S.* MEMBER
4, Cardigan Court, Richmond Hill, Richmond, Surrey.

132. ASTLEY, William MEMBER
Top Flat, Firfield, The Heath, Weybridge, Surrey.

357. AXTON, Edward James, *B.Sc.* FELLOW
41, Wilmot Way, Banstead, Surrey.

B

379. BAKER, Paul William, *A.F.R.Ae.S., A.M.N.Inst.E.* FELLOW
18, Reading Road, Farnborough, Hants.

537. BALL, William Victor MEMBER
1, Weston Avenue, Aston Brook Street, Birmingham, 6.

508. BARFORD, Neil William MEMBER
12, Radcliffe Road, Harrow Weald, Middx.

228. BARNES, H. G. H. MEMBER
66, Whitehouse Avenue, Boreham Wood, Herts.

628. BARNET, Peter Alan MEMBER
4, St. George's House, Coptic Street, W.C.1.

555. BARRETT, William George MEMBER
13, Heversham Road, Bexley Heath, Kent.

612. BARR-WELLS, Donald Reynell, *Grad.I.E.E., Dipl.Far.Hse.* FELLOW
48, Manchester Street, W.1.

263. BATTERSBY, A. FELLOW
65, Cecil Park, Pinner, Middx.

541. BAUM, Richard Myer MEMBER
Stocks Lane Post Office, 1, Dee Banks, Boughton, Chester.

556. BAXTER, Alexander Duncan, *B.Eng., M.Eng., A.F.R.Ae.S., A.M.I.Mech.E.* FELLOW
The Vicarage, East Claydon, Nr. Bletchley, Bucks.

584. BAYNES, Leslie Everitt FELLOW
Foxley Orchard, Holyport, Berks.

648. BEACH, Sydney Alfred, *B.Sc.* FELLOW
32, High Street, Aberystwyth.

99. BEADLE, Alfred Ronald MEMBER
20, Pindock Mews, Warwick Avenue, Maida Vale, W.9.

76. BEAUCHAMP, Geoffrey Thomas MEMBER
62, Hook Road Bungalows, Ampfield, Nr. Romsey, Hants.

695. BEDDALL, Stanley Ernest, *A.F.R.Ae.S.* FELLOW
Flat 1, 1, Heathfield Avenue, Birmingham, 20.

386. BEEBE, Murray C. FELLOW
4300, Via Nivel, Palos Verdes Estates, California, U.S.A.

422. BEEBE, William, *Sc.D., LL.D.* FELLOW
33, West 67th Street, New York City, N.Y., U.S.A.

17. BEIN, Charles MEMBER
55A, St. John's Wood High Street, N.W.8.

715. BELL, Basil Edward MEMBER
BM/BASELL, London, W.C.1.

293. BENNETT, A. J. R. MEMBER
Royal School of Mines, South Kensington, S.W.7.

482. BENNETT, David Hunter, *A.M.I.Mech.E.* FELLOW
"Inveresk," Langholm, Dumfriesshire, Scotland.

649. BENNETT, Maxwell Bruce MEMBER
"Ferndale," Nichols Road, Via Leongatha, Victoria, Australia.

407. BENSTEAD, Leslie James, *L.Inst.P.S.* — MEMBER
13, Achilles Road, N.W.6.

187. BETTS, Anthony Charles George, *B.Sc.* — FELLOW
114, Bowring Park Avenue, Broadgreen, Liverpool, 16.

468. BEVERLEY, William Maynard — FELLOW
Birchmont Road, Scarboro Jnct., Ontario, Canada (c/o Post Office).

360. BIELKOWICZ, Peter, *A.F.R.Ae.S.* — FELLOW
3, Lancaster Grove, N.W.3.

463. BIRKS, Charles William Peter — MEMBER
76, Campbell Road, Stoke-on-Trent, Staffs.

321. BIRTWHISTLE, John Henry — MEMBER
"Chellow-Dene," 2, Princes Drive, Skipton, Yorks.

396. BLEACH, Keith Stuart, — MEMBER
35, Hexham Road, S.E.27.

547. BLYTHE, Robert Maurice — MEMBER
23, Westover Gardens, Gateshead 9, Co. Durham

405. BODDY, Peter — MEMBER
30, Chester Terrace Mews, Regent's Park, N.W.1.

693. BODSWORTH, Richard James — MEMBER
60, Romany Road, Kingsley, Northampton.

489. BOIVIN, Alberic, *B.A., M.Sc.* (*Physics*) — FELLOW
128, Eymond Avenue, Quebec, Prov. of Quebec, Canada.

742. BOLTON, Arnold Hilton — MEMBER
22, Arlington Street, Great Lever, Bolton, Lancs.

634. BOOTH, Peter Rowson, *B.Sc., F.C.S.* — FELLOW
481A, Finchley Road, Hampstead, N.W.3.

544. BOOTHMAN, Miss Norah, *B.Sc., A.R.I.C., F.C.S.* — FELLOW
Luton and South Bedfordshire College, Park Square, Luton.

432. BORY, George Henri — FELLOW
55, Avenue George V, Paris, France.

15. BOULNOIS, Denis L'Estrange — MEMBER
Watermans, Henley-on-Thames, Oxon.

601. BOWMAN, Douglas Alan — MEMBER
P.O. Box 1231, Salinas, California, U.S.A.

780. BRAUN, Professor Dr. Wernher von, *Ord. Res. and Dev. Div. Sub O* (*Rkt.*) — HONORARY FELLOW
Fort Bliss, Texas, U.S.A.

397. BRAVINGTON, Fruin Bruce Charles, *B.A.* — MEMBER
34, Upper Cheyne Row, S.W.3.

216. BREMNER, Kenneth John — MEMBER
78, Grove Road, Shirley, Southampton, Hants.

9. BREMNER, Robert James — FELLOW
78, Grove Road, Shirley, Southampton, Hants.

653. BRIERLEY, Jack Rodney — MEMBER
113, Radcliffe Road, Golcar, Huddersfield.

722. BRITTAIN, P. Ian, *B.Sc.* — FELLOW
55, Wroxham Gardens, Potter's Bar, Middx.

561. BROOKER, Frank — MEMBER
18, Clovelly Court, Upminster Road, Hornchurch, Essex.

85. BROSAN, G. S. — FELLOW
187, Willesden Lane, London, N.W.6.

690. BROUGHTON, Leslie William, *A.M.I.Mech.E.* — FELLOW
18, Grenville Road, Southcourt, Aylesbury, Bucks.

523. BROWN, Arthur Stanley — MEMBER
1a, Galfried Road, Newmarket Road, Cambridge

604. BROWN, Nyal Mortimer — MEMBER
1535, South Cedar Street, Lansing, 10, Michigan, U.S.A.

450. BROWNE, Michael A. — MEMBER
24A, Oxford Road, Manchester, 1, Lancs.

765. BRYCE, John Hedworth — MEMBER
6, Chelsea Grove, Newcastle-on-Tyne, 4.

705. BUCHANAN, Keith — MEMBER
Box 531, Amsterdam, Ohio, U.S.A.

471. BUKOVSKY, Jan Joseph, *A.F.R.Ae.S.* — FELLOW
Mitchell Hall, College of Aeronautics, Cranfield, Bletchley, Bucks.

745. BULLEY, James Arthur, *B.Sc., A.R.I.C., F.C.S.* — MEMBER
5, Wellmeadow Road, S.E.13.

775. BULMER, Henry Kenneth — MEMBER
84, Drayton Park, N.5.

306. BURGESS, David Arthur — MEMBER
18, Melville Avenue, Greenford, Middx.

1. BURGESS, Eric — FELLOW
4, Cordova Avenue, Denton, Manchester, Lancs.

327. BURNABY, Thomas Patrick, *B.A.* — MEMBER
6, Hedgerley Close, Cambridge.

760. BURRAS, William John, *B.Sc.* — FELLOW
2, "Glenburn," Calverley Lane, Horsforth, Yorks.

718. BUTLER, John Lindsay — MEMBER
1, Cliff Grove, Beaumaris, Melbourne, Victoria, Australia.

194. BUTTRISS, Laurence Ewart — MEMBER
The House, Don Street, Rotherham, Yorks.

C

699. CAMERON, Alastair, *B.Sc.* — FELLOW
Staff Hotel, Deep River, Ontario, Canada.

615. CANDLIN, Alfred Hugh Stanton, *B.Sc., A.I.Mech.E.* — FELLOW
c/o Disarmament Branch, Combined Services Divn., 312 H.Q., Kiel, B.A.O.R.

236. CAPLIN, Hyman Harry — MEMBER
104, London Road, Clacton-on-Sea, Essex.

235. CAPLIN, Stephen Dudley — MEMBER
164, Sirdar Road, N.22.

768. CAROLAN, Leonard Robert, *A.R.Ae.S.* — FELLOW
18, Ashton Avenue, Earlwood, Sydney, N.S.W., Australia.

770. CARTER, Kenneth George — MEMBER
4, Buller Road, Wood Green, N.22.

6. CARTER, Leonard James, *F.R.S.A., A.C.I.S.* — FELLOW
21, Mann Street, S.E.17.

513. CASHMORE, David John, *B.Sc.* — FELLOW
36, Martin Way, Morden, Surrey.

549. CASIRAGHI, Ing. Giovanni P. — FELLOW
via Galata 33–5, Genoa, Italy.

630. CAWEIN, Madison, *B.Sc.* — FELLOW
3010 ¼ So. Calhoun, Fort Wayne, Indiana, U.S.A.

498. CHANDLER, Arthur Bertram (*Master Mariner*) — FELLOW
29, Cambridge Road, Hounslow, Middx.

776. CHANT, Robert Seymour — MEMBER
48, Westland Road, Yeovil, Som.

156. CHAPLIN, Nevil John Eugene, *Grad.R.Ae.S.* — FELLOW
2, Pretoria Road, Streatham, S.W.16.

466. CHAPMAN, George Kenneth — MEMBER
23, Farnley Road, South Norwood, S.E.25.

344. CHARLTON, Arthur — MEMBER
782, Filton Avenue, Filton, Bristol, Glos.

757. CHARMAN, John E. — MEMBER
19, Somerset Avenue, Hook, Surbiton, Surrey

747. CHEAL, Joseph John — MEMBER
63, Leigh Road, Eastleigh, Hants.

294. CHRISTENSEN, Dr. Hans Christian — MEMBER
Forsvarets Forskningsinstitutt, Avd. f Kjeml, Lillestrom, Norway.

704. CHRISTOPHER, Peter Alfred Thomas — FELLOW
15, Cove Road, Farnborough, Hants.

2. CLARKE, Arthur Charles, *B.Sc.* — FELLOW
"Ballifants," Bishops Lydeard, Taunton, Somerset.

654. CLARKE, Aubrey Vincent — MEMBER
16, Wendover Way, Welling Kent.

641. CLARKE, Edward — MEMBER
10, Brookfield Terrace, Foxdale St. John, I.O.M.

483. CLARKE, James Gordon — MEMBER
78, Halesowen Street, Blackheath, Nr. Birmingham, Warwicks.

90. CLARKE, Joseph Adam — MEMBER
15, Campden Hill Gardens, Notting Hill Gate, W.8.

485. CLAY, Charles Albert Thomas — MEMBER
102, High Street, Hounslow, Middx.

4. CLEATOR, Philip E. — HONORARY FELLOW
151, Wallasey Road, Wallasey, Ches.

7. CLEAVER, Arthur Valentine, *A.R.Ae.S.* — FELLOW
22, Lyndhurst Gardens, Belsize Park, N.W.3.

609. CLIFTON, Richard — MEMBER
507, Forest Road, London, E.17.

311. COATES, Edmund William, *A.M.I.Mech.E., A.F.R.Ae.S.* — FELLOW
c/o 37, Strathmore Avenue, Leicester.

401. COBB, Flt.-Lt. Henry James — MEMBER
"The Tything," London Lane, Cuckfield, Sussex.

683. COLE, Ernest John — FELLOW
221, Langlands Road, Glasgow, S.W.1, Lanarks.

329. COLLINS, John — MEMBER
185, Bishopsford Road, Morden, Surrey.

650. COLLINS, John Stuart, *B.Sc. Grad.I.Mech.E.* — FELLOW
57, Sherlock Road, Chapelfields, Coventry.

336. CONQUEST, G. R. A., *B.A.* — MEMBER
c/o Foreigh Office, 12–17, Carlton House Terrace, S.W.1.

113. COOPER, Ernest John — MEMBER
46, Lavender Avenue, Mitcham, Surrey.

328. CORNTHWAITE, Leonard Thomas — MEMBER
23, Fulshaw Avenue, Wilmslow, Cheshire.

618. CORPER, Michael — MEMBER
114, Tachbrook Street, London, S.W.1.

669. COURTENEY, William — MEMBER
"Eolka," Pinewalk, Carshalton Beeches, Surrey.

645. CRAWFORD, Robert Stewart — MEMBER
23, Hereford Road, E.11.

285. CROSS, Charles Arthur — MEMBER
"Green Mount," Brockhurst Hill, Northwich, Ches.

682. CROWE, Thomas Albert — MEMBER
14, Manor Way, Worcester Park, Surrey.

651. CROWHURST, Leslie John — MEMBER
60, Sedlescombe Road, S.W.6.

145. CURTIS, John Gordon — MEMBER
63, Broom Avenue, Rotherham, Yorks.

D

427. DANDRIDGE, Michael Percy, *F.R.S.A., A.C.I.S.* — MEMBER
13, Pickhurst Rise, West Wickham, Kent.

154. DANIELS, Douglas Vincent — MEMBER
1, Junction Road, Bath, Somerset.

400. DANN, John Syer — MEMBER
The Old Rectory, Fradswell, Stafford, Staffs.

755. DAUWALTER, Chadwick S. — MEMBER
173, Tacoma Road, Oak Ridge, Tenn., U.S.A.

660. DAVEY, Anthony Reginald — MEMBER
"Studley," Folders Lane, Burgess Hill, Sussex.

307. DAVID, Frederick William, *A.F.R.Ae.S.* — FELLOW
34, Snowden Avenue, Caulfield, S.E.8, Victoria, Australia.

725. DAVIDSON, Denis Alexander — MEMBER
47, Park Avenue, Orpington, Kent.

288. DAVIES, Frank Thomas, *D.C.A., Grad.R.Ae.S.* — FELLOW
15, Caldecote Gardens, Bushey Heath, Herts.

691. DAVIS, George Sumpter Delahaye Coleridge, *A.M.I.Mech.E.* — MEMBER
20a, Petersham Mews, Elvaston Place, S.W.7.

182. DE KONINGH, Gerrit, *Ir., E.I. (Delft), M.R.I.E.* — FELLOW
van der Brugghenstraat 18, Delft, Holland.

158. DELLENDAG, J. C. E. M. — MEMBER
Statenweg 172c, Rotterdam, Holland.

756. DENT, Arthur Henry James — MEMBER
11, Tarset Road, Whitley Bay, Northumberland

504. DE REUCK, Anthony Vivian Smith, *F.R.Met.S.* — FELLOW
111, Onslow Gardens, Wallington, Surrey.

707. DESOUTTER, Denis Marcel — MEMBER
Little Oak, Burney Road, Westhumble, Dorking, Surrey.

89. DICKHOFF, Robert Ernst, *Ph.D.* — MEMBER
315E, 107 Street, New York, 29, N.Y., U.S.A.

700. DICKSON, Roger Savernake, *A.F.R.Ae.S.* — MEMBER
Seascape, Hill Head, Fareham, Hants.

721. DIXON, Alan Edward — MEMBER
9, Selhurst New Court, Selhurst New Road, S.E.25.

771. DOBBIE, Derek, *B.Sc.(Eng.)* — FELLOW
89, St. Nicholas Street, Coventry, Warwickshire.

24. DOBSON, Walter — MEMBER
43, St. Bernard Road, Stockton-on-Tees, Co. Durham.

686. DONALDSON, Ian Stuart — MEMBER
The Firs, Polefield, Prestwich, Manchester, Lancs.

539. DONHOU, Albert Henry — MEMBER
14, James Street, Hounslow, Middx.

478. DOREY, Frank Herbert — MEMBER
2, East Close, Cockfosters, Herts.

364. DOVE, Ernest Baker, *A.R.Ae.S.* — FELLOW
134, Church Hill Road, New Barnet, Herts.

610. DOW, James Parker — MEMBER
East Main Street, R.F.D., 3, East Aurora, New York, U.S.A.

130. DOWELL, Major William Chipchase — MEMBER
119, Watford Road, North Wembley, Middx.

736. DOWSETT, Arthur Raymond Leslie — MEMBER
32, Kings Road, Ditton Hill, Surbiton, Surrey.

E

137. EAGLES, Dennis James — MEMBER
63, Matlock Road, Tyseley, Birmingham, 11.

552. EARNSHAW, Flt.-Lt. Charles Wilfred — MEMBER
2, Derby Road, Milford, Derbys.

303. EDWARDS, Courtenay, *Comp.R.Ae.S.*, — MEMBER
Daily Mail, Northcliffe House, E.C.4.

748. EDWARDS, Peter Frederick Norman — FELLOW
7, Wavertree Road, Worthing, Sussex.

550. ELLIOTT, Sidney William Herbert — MEMBER
297, Princes Road, Dartford, Kent.

47. ELLIS, Charles Alfred Pascoe — MEMBER
37, Hurstbourne Gardens, Barking, Essex.

237. ELLIS, H. J. — MEMBER
57, Mount Pleasant, Barrow-in-Furness, Lancs.

331. ELLISON, Robert, *A.M.I.Chem.E.* — FELLOW
86, Kingsway, Luton, Beds.

433. ELSTUB, St. John de Holt, *B.Sc.* — FELLOW
The White House, Clent, Worcs.

661. ENGELHARD, Naftali Herz — MEMBER
11, Wingfield Road, Whitchurch, Cardiff.

667. ERDMANN, Horst — MEMBER
Home Farm, Invergarry, Inverness-shire.

777. ESNAULT-PELTERIE, Robert — HONORARY FELLOW
6, Rue Bonivard, Geneva, Switzerland.

540. EVANS, David Wilfred Shawyer, *B.Sc., A.R.I.C., F.C.S.* — FELLOW
Nottingham University, University Park, Nottingham.

642. EVERLEY, Geoffrey Trevor — MEMBER
16, Clive Street, Tantany, West Bromwich, Staffs.

291. EYRES, Bernard — MEMBER
9, Leycett Drive, Lawton Moor Road, Northenden, Manchester, Lancs.

F

749. FABRIS, Robert — MEMBER
Box 32, Bardonia, New York, U.S.A.

414. FALKNER, Harold Everitt, *B.A.* (*Cantab*), *A.F.R.Ae.S.* — FELLOW
143, Ashby Road, Loughborough, Leics.

602. FARNOL, Geoffrey Herbert — MEMBER
73, Beeches Road, Great Barr, Birmingham, 22.A.

461. FAULCONER, Ivor Christopher — MEMBER
Little Flanchford, Leigh, Surrey.

146. FEARS, Francis R. — MEMBER
6, Ferme Park Mansions, Ferme Park Road, Crouch End, London, N.8.

135. FIELD, Francis J. MEMBER
79, Lichfield Road, Sutton Coldfield, Warwicks
174. FIELDEN, Henry Edward, *M.Inst.Fuel, M.I.B.E.* FELLOW
6, Beulah Hill, London, S.E.19.
167. FILBEY, Derek MEMBER
66, Blandford Road, Beckenham, Kent.
772. FINCH, BERNARD EPHRAIM, *M.R.C.S., L.R.C.P.,* MEMBER
851, Finchley Road, N.W.11.
646. FINCH, Harold Douglas *B.S.* FELLOW
3722, Belvidere Avenue, Seattle, 6, Wash., U.S.A.
676. FIRSOFF, Valdemar Axel MEMBER
"Rigside," Sannox, Isle of Arran.
66. FISZDON, Wladyslaw, *B.Sc., A.F.R.Ae.S.* FELLOW
ul 6-go Sierpnia 24 (Politechnika) Warsaw, Poland
506. FITZ-GIBBON, William Gerald, *A.R.Ae.S.* FELLOW
"Stanbrook," Hunsdon, Herts.
310. FITZSIMMONS, Robert Arthur MEMBER
c/o 35, South End Road, London, N.W.3.
26. FLANAGAN, Bernard, *B.Sc.* MEMBER
34, Morley Road, Chaddesden, Derby.
10. FLEISHER, Cyril FELLOW
23, Chiltern Street, Baker Street, W.1.
608. FLOWERS, Adrian John MEMBER
47, St. David's Road, Southsea, Hants.
65. FOLEY, John, *Grad.R.Ae.S., Grad.I.Mech.E.* FELLOW
The Oaks, Victoria Road, Farnborough, Hants.
572. FOSS, John Kenneth Beart MEMBER
27, Allport Road, Bromborough, Cheshire.
548. FOSTER, Gerald Victor MEMBER
19, Salisbury Road, Barnet, Herts.
684. FOXLEY, Frank MEMBER
340, High Street, Lewisham, S.E.13.
480. FRANKLIN, Eric MEMBER
76, Craven Street, Hightown, Manchester, 8, Lancs.
635. FRODSHAM, George Arthur MEMBER
31, Downhurst Avenue, Mill Hill, N.W.7.
758. FYSH, W. Hudson, *D.F.C., A.F.R.Ae.S.* FELLOW
Qantas Empire Airways, Ltd., Box 489, G.P.O. Sydney, N.S.W., Australia.

G

247. GARLAND, Capt. R. S. MEMBER
64A, Villiers Avenue, Mordale, Sydney, Australia.
694. GARTMANN, Heinz Alfred FELLOW
Klotzmullerstrabe 113, Landshut (Bavaria), Germany.
5. GATLAND, Kenneth William FELLOW
17, Southcote Avenue, Tolworth, Surbiton, Surrey.
363. GEORGES, James Athol MEMBER
15, Henry Street, Abbotsford, Melbourne, Victoria, Australia.
528. GERARD, Vernon Bruce, *M.Sc.* FELLOW
35, Chancellor Street, Shirley, Christchurch, New Zealand.
617. GHASWALA, Soli Kaikobad, *F.R.S.A., F.R.Met.S., B.E. (Bombay)* FELLOW
"Edena," Queens Road, Fort, Bombay, India.
764. GIACOMELLI, Lorenzo Orestes MEMBER
Santa Fe 4124, Buenos Aires, Argentina, S. America.

751. GIANNINI, Dr. Gabriel Maria — FELLOW
254, West Colorado Street, Pasadena, 1, Cal., U.S.A.

54. GIBB, John Robert, *A.R.Ae.S.* — FELLOW
40, Leamington Road Villas, London, W.11.

692. GIBBS-SMITH, Charles H., *M.A., F.R.S.A., Comp.R.Ae.S.* — MEMBER
720, Kensington Close, W.8.

39. GIBSON, W. A., *L.R.C.P., L.D.S.* — MEMBER
Boghead House, Bathgate, West Lothian.

40. GILBERT, Edward C. — MEMBER
11, Riddy Lane, Luton, Beds.

12. GILBERT, Lionel, *A.R.C.S., B.Sc.* — FELLOW
46, Lancaster Gate, W.2.

122. GILES, Cedric — FELLOW
1005, East 40th Street, Brooklyn 10, New York, U.S.A.

74. GILL, R. H. — MEMBER
27, Prospect Road, New Barnet, Herts.

123. GILLINGS, Walter H. — MEMBER
115, Wanstead Park Road, Ilford, Essex.

424. GLASS, Jerzy S. — MEMBER
57, Philbeach Gardens, London, S.W.5.

496. GLENDENNING, Raymond — MEMBER
43, Morgan Street, Southwick, Sunderland, Co. Durham.

701. GOETHE, Dr. Johann Wolfgang — FELLOW
77, Falkstrasse, Frankfurt am Main-West, Germany.

444. GORDON, John — MEMBER
105, Braidholm Road, Giffnock, Glasgow.

729. GREEN, Leslie Norman — MEMBER
4, Sea Road, Wallasey, Ches.

362. GREENFIELD, Anthony Aynsley — MEMBER
"Breinton," Fryern Road, Storrington, Nr. Pulborough, Sussex.

147. GREENWOOD, Laurence — MEMBER
48, Mayne Avenue, Leagrave, Luton, Beds.

300. GREENWOOD, Stuart William, *B.Sc.* — FELLOW
General Delivery, MacDonald College, Ste-Anne de Belle vue, Quebec, Canada.

464. GRIFFITHS, John Frederick, *B.Sc.* — FELLOW
29, Ingleton Avenue, Welling, Kent.

520. GRIMSTON, Roger Anthony — FELLOW
286, Whitchurch Lane, Edgware, Middx.

553. GROVES, Leonard Hubert — MEMBER
4, Hayne House, Penzance Place, Holland Park, W.11.

462. GUALTIERI, Lt. Angelo — FELLOW
12, Ashburnham Mansions, Ashburnham Road, Kings Road, Chelsea, S.W.3.

334. GUSSALLI, Ing. Luigi — FELLOW
Monte Suello 4, Brescia, Italy.

H

346. HALL, Cyril Lionel — MEMBER
29, Aspinall Road, Brockley, S.E.4.

592. HALL, Dennis — MEMBER
47, Calgary Street, Mt. Eden, S.2, Auckland, New Zealand.

665. HALL, Herbert — FELLOW
7, Kingsland Avenue, Oakhill, Stoke-on-Trent, Staffs.

380. HAMMOND, Alfred Holmes, *A.R.Ae.S.* — MEMBER
18, Canonbie Road, Forest Hill, London, S.E.23.

115. HAMPTON, Capt. Trevor Arthur, *A.F.C.*, — FELLOW
34, Hinstock Road, Handsworth Wood, Birmingham.

157. HANSON, Maurice Kimpton — MEMBER
95, Mere Road, Leicester.

666. HARKNETT, Richard Vernon — MEMBER
31, Vernon Drive, Stanmore, Middx.

33. HARPER, Harry — MEMBER
Hatherton, Worple Road, Epsom, Surrey.

262. HARPER, Richard Frederick, *Grad.I.Mech.E.*, *Grad.I.E.E.* — FELLOW
119, Farley Hill, Luton, Beds.

183. HARRIS, Benjamin Denzil — MEMBER
341, Gander Green Lane, North Cheam, Surrey.

637. HARRIS, David Wilson — MEMBER
74, Lisbon Avenue, Fulwell Park, Twickenham, Middx.

319. HARRISON, Dennis Clifford, *Grad.I.P.E.* — FELLOW
5, Argyle Close, West Ealing, W.13.

425. HARRISON, John Edgar Alfred, *B.Sc.* — FELLOW
59a, Galgate, Barnard Castle, Co. Durham.

41. HARROP, Gerard R. — MEMBER
La Preference, St. Martin, Jersey, Channel Islands.

580. HARTLEY, Donald Edward — MEMBER
Farnborough Grange Hostel, Farnborough, Hants.

516. HARVEY, Peter John — MEMBER
41, Bressey Grove, South Woodford, E.18.

439. HAWES, Douglas Owen, *B.Sc.*, *A.M.Inst.E.E.* — FELLOW
65, Oakwood Crescent, Winchmore Hill, N.21.

178. HAZELL, William Selwyn Victor — MEMBER
Penwaurgoch House, Penturyn, Treharris, Glam.

518. HEALEY, Gordon Terry — MEMBER
23, Grove Hill, Caversham, Reading, Berks.

428. HEINLEIN, Robert Anson — MEMBER
5433, Harold Way, Los Angeles, 27, California, U.S.A.

538. HELLINGS, Brian, *F.R.Met.S.* — FELLOW
Kapuskasing, Ontario, Canada.

585. HENDERSON, Ronald Robert — MEMBER
96, Gladstone Avenue, Northcote, Melbourne, Victoria, Australia.

95. HENDLEY, Kenneth Middleton — MEMBER
32, Farley Avenue, Luton, Beds.

728. HENNIKER-HEATON, Peter Joseph, *B.A.* — MEMBER
14, Ladbrooke Square, W.11.

594. HENRY, Irvin George — MEMBER
2438, College Avenue, Berkeley 4, California, U.S.A.

469. HERMAN, Ralph Bertrand, *Grad.I.E.E.* — FELLOW
77, Fairholt Road, London, N.16.

265. HEWITT, S/Ldr. Anthony Henry — MEMBER
59, Hill Road, Pinner, Middx.

196. HICK, William Edmund, *Comp.R.Ae.S.*, *B.M.*, *B.S.* — MEMBER
66, Bishops Road, Trumpington, Cambridge.

632. HIGGINS, Geoffrey Thomas — MEMBER
Flat 2, "St. Owens," Silverdale Road, Burgess Hill, Sussex.

525. HOARE, Terence — MEMBER
86, Woolacombe Road, London, S.E.3.

234. HODGE, F/Lt. S. R. — MEMBER
Officers' Mess, R.A.F. Watton, Norfolk.

14. HOLLINGBERY, Raleigh George — MEMBER
38, West Cromwell Road, S.W.5.

206. HOOPER, Geoffrey Grant — MEMBER
c/o Lloyds Bank, Ltd., 6, Pall Mall, S.W.1.

596. HOPE, Earl R. — MEMBER
305, Wilbrod Street, Ottawa, Ontario, Canada.

680. HOPE-JONES, Edward Frederick, *M.A., A.M.I.Civ.E., F.R.A.S.* — FELLOW
68, Casino Avenue, S.E.24.

258. HORNE, George Winzar — MEMBER
45, Alderbrook Road, Clapham South, S.W.12.

577. HORNIGOLD, Major James, *A.M.I.Mech.E.* — FELLOW
11, Victoria Terrace, Victoria Street, Chesterfield, Derbys.

744. HOURIGAN, Harry Frank Derham — MEMBER
177, Scribers Lane, Hall Green, Birmingham, 28.

301. HOUTMAN, Johan Hendrick — MEMBER
van Leeuwenhoeksingel 20, Delft, Holland.

280. HOWELL, Owen Bulmer, *M.A.* — MEMBER
Jacmill, Harfield, Middx.

246. HOYLE, Eric Beverley — MEMBER
22, Southdown Avenue, Boston Manor, W.7.

655. HUGGINS, Peter Joseph Gibson, *B.Sc. (Eng.), Grad.I.Mech.E.* — FELLOW
Gamlingay Rectory, Sandy, Beds.

242. HUGHES, David R. — MEMBER
339, Upton Road, Noctorum, Birkenhead, Cheshire.

372. HUGHES, John Frank — MEMBER
106, Okehampton Crescent, Welling, Kent.

30. HUMPHRIES, John, *B.Sc. (Eng.), A.M.I.Mech.E., A.F.R.Ae.S.* — FELLOW
97, Churchill Avenue, Southcourt, Aylesbury.

445. HUNT, Horace Charles Colin, *F.R.A.S.* — MEMBER
5, Stoke Road, Aylesbury, Bucks.

446. HURDEN, Dennis, *B.A.* — FELLOW
93, Canley Road, Coventry, Warwicks.

723. HURFORD, James Harry — MEMBER
A.S.T. Club, Hamble House, Hamble, Southampton, Hants.

603. HURMAN, Brian Risdon — MEMBER
A.S.T. Club, Hamble House, Hamble, Southampton, Hants.

358. HURRELL, Ian Murray — MEMBER
c/o Lloyds Bank, Ltd., Highcliffe, Hants.

582. HUTCHINGS, John Brian — MEMBER
27, Elmwood Avenue, Hoole, Chester.

I

271. INGRAM, Kenneth — MEMBER
26, Trevor Square, S.W.7.

126. IRVING, Leslie, *A.M.I.E.E.* — FELLOW
28, Cannon Hill Lane, Merton Park, London, S.W.20.

679. ISHERWOOD, Eric — MEMBER
128, Westdale Lane (East), Gedling, Notts.

J

87. JACKSON, Colin Dacre — MEMBER
c/o 8, Geoffrey Road, Shirley, Nr. Birmingham.

574. JACKSON, Francis Thomas — MEMBER
6, Colvin Road, East Ham, London, E.6.

333. JAMES, Arthur, *Comp.R.Ae.S.* — FELLOW
87, Rawlings Road, Bearwood, Smethwick 41, Staffs.

176. JEFFREYS, John Alexander David — MEMBER
2, Marchmont Gardens, Richmond, Surrey.

677. JOSLING, Douglas Hector, *Grad.I.E.E.* — FELLOW
c/o Rahman Hydraulic Tin, Ltd., Intan, Perak, Malaya.

K

743. KAISER, Hans Karl — MEMBER
(21a), Brackwede (Westf), British Zone of Germany.

252. KAY, Harold Tutt, *M.R.C.S., L.R.C.P.* — FELLOW
321, Brownhill Road, Catford, S.E.6.

421. KELL, Clifford, *A.M.I.Mech.E., A.F.R.Ae.S.* — FELLOW
Technical Staff Mess, Royal Aircraft Establishment, Farnborough, Hants.

281. KEMP, Peter John, *B.Sc.* — MEMBER
112, Dudley Road, Sedgley, Nr. Dudley, Worcs.

716. KENNEDY, Charles — MEMBER
57, Ferguson Avenue, Renfrew, Scotland.

295. KENNEDY, Warnett, *D.A., A.M.T.P.I., M.I.S.A.* — MEMBER
11, Bentinck Street, London, W.1.

570. KIMBERLEY, Alan John — MEMBER
"Edgcote," Waldo Road, Bracebridge Heath, Lincoln.

739. KING, W. G., *A.I.M.* — FELLOW
155, Colin Crescent, Hendon, N.W.9.

131. KINGSNORTH, Arthur — FELLOW
"Denley Cottage," Rickmansworth Road, Amersham, Bucks.

440. KINGSWELL, Harold Douglas — MEMBER
16, Sandringham Road, Watford, Herts.

338. KLAPPER, Harris — MEMBER
40, Thornton Avenue, London, S.W.2.

533. KNEWSTUB, Graham — FELLOW
57, Laurel Road, Leicester, Leics.

479. KOOY, Dr. Ir. J. M. J. — FELLOW
Valkenboschlcade 656, der Haag, Holland.

50. KUNESCH, Anthony Martin — MEMBER
c/o 28, Alexandra Drive, Surbiton, Surrey.

L

535. LANE, Dennis Edward — MEMBER
44, Hodder Drive, Perivale, Middx.

663. LANE, Sidney Melville — MEMBER
4a, Spurway Parade, Woodford Avenue, Ilford, Essex.

564. LANGFIELD, Ronald Alexander, *B.Eng.* — MEMBER
Priory Nook, St. George's Mount, New Brighton, Cheshire.

731. LAST, Anthony John — MEMBER
25, Hillcrest Gardens, Hinchley Wood, Esher, Surrey.

517. LATHAM, Ronald Luke, *Grad.I.Mech.E.* — FELLOW
2, Sutton Oak Road, Streatly, Sutton Coldfield, Warwicks.

332. LAVER, John William — MEMBER
94, Kingsway, Luton, Beds.

34. LAWDEN, Derek Frank, *M.A.* — FELLOW
2, Axis Road, Watchfield, Nr. Swindon, Wilts.

104. LAWLER, James Ernest — MEMBER
33, Manor Way, Woodmansterne, Banstead, Surrey.

734. LAWSON, Gerald — MEMBER
17, Springfield Avenue, Mt. Albert, Auckland, New Zealand.

207. LEMAN, Roy Richard — MEMBER
1, Bromwall Road, Billesley, Birmingham.

148. LEVESLEY, Mark Fletcher, *B.Eng.* — FELLOW
Shell Co. of Venezuela, Cardon Refinery, Las Piedras, Estado Falcon, Venezuela, S. America.

390. LEY, Willy — FELLOW
Pine Manor, Montvale, N.J., U.S.A.

290. LIGHTBOWN, John, *M.Inst.E.E.*, *A.M.I.Mech.E.*, *M.I.B.E.*, *A.M.I.I.A.* — FELLOW
60, Wragby Road, Lincoln.

339. LOCKTON, Cedric Phillips, *A.M.I.E.E.*, *M.Sc.* — MEMBER
31, Barnfield, Urmston, Manchester, Lancs.

767. LONGMAN, David George Keith — MEMBER
16, Whistler Gardens, Stag Lane, Edgware, Middx.

69. LOW, Professor Archibald Montgomery, *A.C.G.I.*, *D.Sc.*, *F.C.S.*, *F.I.P.I.*, *F.I.Arb.* — FELLOW
1, Woodstock Road, London, W.4.

48. LUCEY, S/Ldr. Antony George — MEMBER
c/o Harding Rhodes, Ltd., Globe Road, Leeds, 11, Yorks.

198. LUCIEN, Capt. René, *A.F.R.Ae.S.*, *A.F.I.T.A.* — FELLOW
75, Rue Denfert Rochereau, Paris, XIV, France.

670. LUCY, Dennis Harold — MEMBER
11, Hereford Avenue, East Barnet, Herts.

68. LYON, George, *B.Sc.*, *A.M.I.E.E.*, *Grad.I.Mech.E.* — MEMBER
6, Craven Court, Greenhill Park, Harlesden, N.W.10.

M

16. MACDONALD, Thomas Logie, *M.A.*, *B.Sc.*, *F.R.A.S.*, *F.R.S.E.*, *F.P.S.* — FELLOW
12, Norfolk Road, Carlisle, Cumb.

502. MADDOCK, D. Peter, *B.Sc.*, *Grad.I.Mech.E.*, *Dipl.* (*Eng.*) *UCN* — FELLOW
Rocket Propulsion Dept., R.A.E., Westcott, Nr. Aylesbury, Bucks.

116. MANISTY, Major G. J. E. — MEMBER
Hillside, Drewsteignton, Exeter, Devon.

774. MANLEY, Horace, *Ph.D.*, *B.Sc.* — MEMBER
74, Anerley Road, S.E.19.

599. MARLER, Gilbert Lee — MEMBER
74, Whateley Road, Handsworth, Birmingham, 21.

703. MARSHALL, Henry James — MEMBER
299, Grove Green Road, E.11.

724. MARTIN, Jack Richard — MEMBER
120, Seventh Avenue, Manor Park, E.12.

720. MASEFIELD, Peter, *M.A.*, *F.R.Ae.S.*, *G.I.Mech.E.* — FELLOW
"Rosehill," Wray Common Road, Reigate, Surrey.

105. MATHER, Mrs. Sheila Margaret — MEMBER
9, Swanwick Street, Old Whittington, Chesterfield, Derbys.

55. MAXWELL, John Burns — MEMBER
253, Ashdale Avenue, Toronto 8, Ontario, Canada.

475. MAXWELL, Major Leigh — MEMBER
30, Holbein House, Holbein Place, London, S.W.1.

752. MAXWELL, Walter Bernard (Jnr.) MEMBER
9, Wood Avenue, Toronto, 12, Ontario, Canada.

312. MAY, Leonard George MEMBER
30, Edward Street, Upper Eastville- Bristol, 5, Glos.

141. MAYNARD, John Kenneth, *Grad.I.E.E., Fav.Hse.Dipl.* FELLOW
7, Eastbrook Road, Blackheath, S.E.3.

227. MCGUIGAN, Laurence Michael MEMBER
14, Griffith Avenue, Malahide Road, Dublin, Eire.

426. MEACOCK, Frederick Thomas, *A.F.R.Ae.S.* FELLOW
123, Whitchurch Gardens, Edgware, Middx.

13. MEDHURST, Richard George, *B.Sc.* MEMBER
126, Finborough Road, West Brompton, S.W.10.

209. MEERHOLZ, Edgar Francis MEMBER
54, Downing Mansions, Eloff Street, Johannesburg, South Africa.

565. MELHUISH, Charles Antill, *B.Eng., B.Civ.E.* MEMBER
26a, South Road, Brighton Beach, Melbourne, S.5, Victoria, Australia.

668. MILES, Kenneth Gordon Villette MEMBER
Fir Tree Cottage, Itchenor, Chichester, Sussex.

359. MILNE, Herbert Valentine Richmond, *B.A.* MEMBER
c/o Lloyds Bank, Ltd., Leamington Spa, Warwicks.

304. MITCHELL, Frederick MEMBER
11, College Court, College Crescent, London, N.W.3.

64. MOLYNEUX, W. G., *B.Sc.* MEMBER
17, Fellows Road, Farnborough, Hants.

675. MONK, Anthony John, *Grad.R.Ae.S., Grad.I.Mech.E.* MEMBER
The Anchorage, Kingsdown Road, Kingsdown, Deal, Kent.

486. MONK, Patrick William Charles MEMBER
210, London Road, Wokingham, Berks.

763. MOORAT, Alfred Joseph Gregory MEMBER
Ionospheric Research Station, Raffles College, Singapore, Malaya.

619. MOORE, Patrick A. MEMBER
Glencathra, Worsted Lane, East Grinstead, Sussex.

762. MORGAN, Dudley F. A. E. D. MEMBER
District Officer, Simanggang, Sarawak.

180. MORGAN, James C., *B.A.Sc., M.A.* MEMBER
177, Keewatin Avenue, Toronto 12, Canada.

629. MORRIS, William Edward, *Grad.I.Mech.E.* MEMBER
Schoolhouse, Sarn, Newtown, Montgomeryshire.

384. MOUNTAIN, Thomas Henry MEMBER
16, Guthrie Street, Hamilton, Lanarks.

212. MULLERVY, John Francis MEMBER
72, Burnt Ash Lane, Bromley, Kent.

708. MULRONEY, Edward Richard, *A.M.I.B.E.* MEMBER
44, Bath Street, Leamington Spa, Warwicks.

664. MUNDEN, Bryan Ross Michael MEMBER
11, Elgar Avenue, Tolworth, Surbiton, Surrey.

369. MUNRO, James Copeland MEMBER
38, Queen's Terrace, Ayr, Scotland.

375. MURRAY, Frederick George MEMBER
44, Victoria Road, Barking, Essex.

659. MUSSELL, Howard J. MEMBER
206, E. Hermosa Street, Santa Maria, California, U.S.A.

N

185. NEAT, Wilfrid N., *B.A., A.F.R.Ae.S.* — FELLOW
70, Kingshill Avenue, Kenton, Harrow, Middx.

773. NEBBIA, Giorgio — MEMBER
Via Belmeloro 4, Universita degli Studi Instituto di Merceologia, Bologna, Italy.

106. NEUMARK, Otto Walter — FELLOW
c/o C. A. P. Ellis, 37, Hurstbourne Gardens, New Barking.

623. NEVES, Percy Ronald Haisell — FELLOW
29, Welbeck Ave., Highfield, Portswood, Nr. Southampton.

129. NEWMAN, John Oswald Henry — MEMBER
36, Bulstrode Avenue, Hounslow, Middx.

658. NEWMAN, Sir Ralph Alured, *B.A., M.A.* — FELLOW
11, Eastcheap, London, E.C.3.

62. NICOLL, Norman Robson — MEMBER
c/o "Westmead," Whetstone Lane, Aldridge, Staffs.

117. NONWEILER, Terence R. F., *B.Sc.* — FELLOW
4, Alexandra Close, Netley Street, Farnborough, Hants.

434. NORMAN, Derek John — MEMBER
32, Hillcrest Road, Romford, Essex.

282. NORMAN-WILSON, Eric — FELLOW
3E, Grove End House, St. John's Wood Road, N.W.8.

371. NYE, Edwin Richard — MEMBER
20, Bramley Road, Southgate, London, N.14.

O

734. OBERTH, Professor Hermann — HONORARY
(13a) Feucht bei Nurnberg, Pfintzingstr. 74, 1, U.S. Zone, Germany. — FELLOW

272. O'BRIEN, Peter Ivan Douglas — MEMBER
Kenfield Hall, Pelturn, Canterbury, Kent.

706. O'HERLIHY, Frank — MEMBER
18, Dunollie Road, Kentish Town, N.W.5.

25. OLSVANGER, Dr. Immanuel, *Ph.D.* — FELLOW
3, Gaza Road, Jerusalem, Palestine.

521. O'NIONS, Albert Edward, *A.M.I.Mech.E., A.R.Ae.S., A.M.I.A.E.* — FELLOW
11, Park Close, Hampton, Middx.

515. OSBORNE, Basil Whitworth, *B.Sc., A.B.I.R.E.* — FELLOW
Ionospheric Research Station, c/o Raffles College, Singapore, Malaya.

149. OVENDEN, Michael William, *B.Sc., F.R.A.S.* — FELLOW
55, Woodlark Road, Cambridge.

P

152. PAGANINI, Dr. Robert — MEMBER
Burgerheim, St. Gall, Switzerland.

52. PAGE, Ernest Basil — MEMBER
2, Bedhampton Road, Bedhampton, Havant, Hants.

738. PALMER, Frederick Clement — MEMBER
28, Dunley Way, Lutterworth, Nr. Rugby, Warwicks.

467. PARISH, Ralph William — MEMBER
c/o 6, Lovelace Road, East Barnet, Herts.

639. PASCOE, Kenneth Langon — FELLOW
115, Hermon Hills, South Woodford, E.18.

750. PATCHETT, Mrs. Mary Elwyn — MEMBER
10e, Nevern Place, London, S.W.5.

622. PATRICK, Paul J. — MEMBER
Box 2386, Anchorage, Alaska, U.S.A.

697. PAUL, Rodney Alan Wyatt — MEMBER
Hay Place, Binstead, Nr. Alton, Hants.

382. PEACOCK, George James — MEMBER
8, Arragon Gardens, West Wickham, Kent.

761. PEAKE, Charles Walter — MEMBER
c/o 10, Golf Links Avenue, Oakleigh, S.E.12, Victoria, Australia.

56. PEARCE, Donald George — FELLOW
15, Osborne Court, The Parade, West Cowes, I.W.

184. PEARSON, William Fletcher — MEMBER
3, Ecclesburn Avenue, East Park Parade, Leeds, 9.

413. PECK, Merritt Edward — MEMBER
214, Lynnwood, Lincoln Heights, Jeffersonville, Indiana, U.S.A.

737. PEDEN, Kenneth, *Grad.I.E.E.* — FELLOW
3, Upper Charleville Street, Belfast, Co. Antrim.

726. PEMBERTON, John Entwistle — MEMBER
47, Chorley Old Road, Bolton, Lancs.

20. PEPPER, Charles Henry, *B.A.* — MEMBER
23, Hardwicke Way, Hamble, Southampton, Hants.

606. PERIDIER, Julien, *F.R.A.S.* — MEMBER
16, rue Cassette, Paris VI, France.

741. PESEK, Professor Rudolf — FELLOW
681, Pod vilami, Prague XIV, Czechoslovakia.

298. PIENNE, Miss Yvette — MEMBER
10, Lambolle Road, London, N.W.3.

355. PILLING, Frederic, *A.F.R.Ae.S.* — FELLOW
"Box Cottage," North Road, Horndean, Hants.

753. PINFOLD, Raymond Neville Francis — MEMBER
9, Stonehill Avenue, Birstall, Leicester.

702. PIRANI, Felix Arnold Edward, *B.Sc.* — MEMBER
Dept. of Mathematics, Carnegie Institute of Technology, Schenley Park, Pittsburg 13, Penn., U.S.A.

779. PIRQUET, Ing. Guido von — HONORARY FELLOW
Wien XXII, 149 Austria.

711. PITTENDRIGH, Lenus Walter Duff, *A.M.I.E.E.*, *A.M.I.Brit.I.R.E.* — FELLOW
8, Hillside, Harwell, Didcot, Berks.

714. PLATT, James J. — MEMBER
50, Linden House, Linden Grove, S.E.15.

387. PORTER, Kenneth Henry, *A.R.Ae.S.* — FELLOW
8, Greens School Lane, Cove, Farnborough, Hants.

545. POWELL, Michael — MEMBER
2, Ilchester Place, London, W.14.

652. POWERS, William Treval — MEMBER
413, South Lincoln Street, Hinsdale, Illinois, U.S.A.

710. PRICE, Derek John, *B.Sc.*, *A.Inst.P.*, *Ph.D.* — FELLOW
No. 7, Raffles College, Singapore, Malaya.

644. PROBSTEIN, Ronald F. — FELLOW
306, West 93 Street, New York, 25, N.Y., U.S.A.

168. PROBY, Richard — MEMBER
Berry Leas, Elton, Peterborough, Northants.

522. PROUDLOCK, Ronald — MEMBER
42, Clementina Street, Sunderland, Co. Durham.

566. PRUTTON, Aubrey Cyril — MEMBER
84, Monkleigh Road, Morden Park, Surrey.

674. PURCHAS, Keith Jenour Morse — MEMBER
c/o 12, The Drive, Henleaze, Westbury-on-Trym, Glos.

226. PURCHASE, Leslie John — MEMBER
National Service Hostel, Bicester Road, Aylesbury, Bucks.

112. PYLE, Edward John — MEMBER
H.M. Chronometer Dept., Royal Greenwich Observatory, Herstmonceux Castle, Nr. Hailsham, Sussex.

R

709. RALPHS, Stanley — MEMBER
92, Lonsdale Street, Hanley, Stoke-on-Trent, Staffs.

573. RAMBERG, Frederick Stanley — MEMBER
21, Glendower Avenue, Broad Lane, Coventry, Warwicks.

283. RAMSDEN, Geoffrey Reeve — MEMBER
71, Oaklands, Rastrick, Brighouse, Yorks.

345. RAMSDEN, Philip, *B.Sc.* — FELLOW
92, St. Enoch's Road, Wibsey, Bradford, Yorks.

248. RATHBONE, J. R. W. — MEMBER
13, East Front Road, Pagham Beach, Nr. Bognor Regis, Sussex.

203. RECA, Jorge Felipe — MEMBER
(Ypf) Destileria Fiscal La Plata, Puerto La Plata, Argentina, S. America.

495. REDMAN, Alan Henry — MEMBER
"Glen-Devon," Bury Street, Lower Edmonton, London, N.9.

324. REES, Gwilym Jenkyn — MEMBER
The Woodlands, Brynmenyn, Nr. Bridgend, Glam.

560. REEVES, Kenneth Raymond — MEMBER
3, Clive Court, Northdown Road, Cliftonville, Margate.

404. REID, Mrs. Vera W. — MEMBER
133, Gloucester Place, London, N.W.1.

361. RENACRE, Basil John — MEMBER
c/o Shanghai Power Co., 181, Nanking Road, Shanghai, China.

493. RICHARDSON, Dr. Robert Shirley — MEMBER
Mount Wilson Observatory Office, 813, Santa Barbara Street, Pasadena, 4, California, U.S.A.

302. RICKARDS, David A. — FELLOW
212, Walnut Street, Aurora, Illinois, U.S.A.

524. RIDLEY, Cecil Lawrence — MEMBER
The Forge and Workshop (Rear of Russell Cottages), Lower Willingdon, Nr. Eastbourne, Sussex.

501. REIDEL, Walter Julius Hermann — FELLOW
RAE/RPD, Westcott, Nr. Aylesbury, Bucks.

576. RIMMER, Bertrand Anthony — MEMBER
10, Talbot Avenue, Oxhey, Herts.

719. ROBERTSON, Ian Wedderburn Clunie — MEMBER
Wendover Lodge, Welwyn, Herts.

477. ROBINSON, Robert Theophilus — MEMBER
8, Saxon Crescent, Humbledon, Sunderland, Co. Durham.

551. ROELICH, Mrs. Mary Webster, *M.A.* — MEMBER
3, Guildford View, Upper Hale, Farnham, Surrey.

127. ROSENTHAL, Dr. Fritz — MEMBER
Schlossgartenplatz 11, (16) Darmstadt, U.S. Zone, Germany.

8. Ross, Harry Ernest — FELLOW
National Service Hostel, Flackwell Heath, High Wycombe, Bucks.

593. ROTHERHAM, Arthur Collin — MEMBER
"The Shack," Hill Lane, Bassetts Pole, Sutton Coldfield, Warwicks.

688. ROWE, Lawerence Frederick William, *M.B., Ch.B.* — FELLOW
Glenview, Gorebridge, Midlothian.

84. ROY, Archibald Edmiston — MEMBER
51, Cresswell Street, Hillhead, Glasgow, W.2, Lanarks.

746. ROYDS, James Alfred — MEMBER
16, Heald Avenue, Rusholme, Manchester, 14, Lancs.

437. RUNDLE, Alan Trevor — MEMBER
15, Byron Avenue, Balby, Doncaster, Yorks.

318. RUNDLE, Maurice, *Grad.I.E.E., Grad.I.Mech.E.* — FELLOW
15, Byron Avenue, Balby, Doncaster, Yorks.

689. RUNDO, John, *B.Sc.* — FELLOW
8, Morris Road, Farnborough, Hants.

754. RUSSO, Rosario, *B.Eng.* — FELLOW
328, Upper Roma Street, Brisbane, Australia.

643. RYMER, Harry R. — MEMBER
Dearborn Observatory, Northwestern University, Evanston, Illinois, U.S.A.

S

165. SAGGERS, Wilfred Norman — MEMBER
12, Henrietta Street, Waverley, Sydney, N.S.W., Australia.

181. SAMARAS, D. George M. O., *D.Sc., A.F.R.Ae.S.* — FELLOW
Office of Air Research, Air Material Command, W–P–AFB, Dayton, Ohio, U.S.A.

579. SANDERS, Edward Seymour — MEMBER
2, Sweet Briar Green, London, N.9.

354. SANDERS, Vincent Tilney — MEMBER
c/o Grindley's Bank, Ltd., 54, Parliament Street, London, S.W.1.

778. SÄNGER, Dr. Ing. Eugen — HONORARY FELLOW
Courcelle sur Yvette, S. et O., Route de Madrid, Villa Uzan, France.

766. SCAMMELL, Rodney Jack, *B.Sc.* — FELLOW
35, Coolhurst Road, Crouch End, N.8.

476. SCANDRETT, Eric Vincent — MEMBER
86, Warrington Road, Ince, Wigan, Lancs.

408. SCHAEFFER, Herbert — FELLOW
83–26, Vietor Avenue, Elmhurst, New York, N.Y., U.S.A.

616. SCHAUB, Darwin Frederick, *B.S.* — MEMBER
85, Barrow Street, New York, 14, N.Y., U.S.A.

740. SCHMIDTMAYER, Josef — FELLOW
1086, Brinicka, Prague XIV, Czechoslovakia.

494. SCHUMACHER, Goran William — MEMBER
Sannagatan 21, Kristinehamn, Sweden.

153. SCHUPAK, Nathan — MEMBER
579, Fort Washington, New York, 33, N.Y., U.S.A.

557. SCOTT, James Kelvin, *B.E., Grad.I.E.E.* — FELLOW
c/o Dairy Research Institute, P.O. Box 602, Palmerston North, New Zealand.

96. SEDDON, F/Lt. Harry — MEMBER
54, Union Street, Leigh, Lancs.

418. SENOGLES, George — MEMBER
20, Hadfield Street, Hathershaw, Oldham, Lancs.

179. SERWACKI, Thaddeus — MEMBER
58, rue Mazarin, Paris 5, France.

685. SHARP, Eric Harold, *B.S. (Eng.)* — FELLOW
"Woodview," Abbess Roding, Nr. Ongar, Essex.

401. SHAW, Frederick — MEMBER
1, Valentia Place, Newcastle, Co. Down.

366. SHAW, George Bernard — MEMBER
Ayot Saint Lawrence, Welwyn, Herts.

18. SHAW, W. R. Courtenay — MEMBER
Rood Ashton, Trowbridge, Wilts.

620. SHEARLY, Clifford — MEMBER
19, Idmiston Road, Worcester Park, Surrey.

32. SHEPHERD, Leslie R., *B.Sc., A.Inst.P.* — FELLOW
28, Avon Road, Chilton, Berks.

454. SHIPP, Horace Frederick — MEMBER
11, Hickman Road, Chadwell Heath, Romford, Essex.

638. SHUTE, Cyril, *B.Sc., A.M.I.E.E.* — FELLOW
19, Lawn Road, Stafford.

296. SILK, Barry A. G. — MEMBER
44, Croftdown Road, Parliament Hill Fields, London, N.W.5.

435. SIMONS, C. Dewar — MEMBER
Windrode House, Seagate Road, Staten Island 5, New York, N.Y., U.S.A.

500. SIMPSON, Albert — MEMBER
15, Macoma Terrace, Plumstead, S.E.18.

733. SIMPSON, Blyth Forrester — MEMBER
North Inchmichael, Errol, Perthshire, Scotland

317. SIMPSON, John Egerton, *M.A.* — FELLOW
Leighton Park School, Reading, Berks.

51. SLATER, Alan Edward, *M.A., M.R.C.S., L.R.C.P., F.Z.S., F.R.Met.S.* — FELLOW
Dell Farm, Whipsnade, Dunstable, Beds.

299. SLATER, Eliot Trevor Oakeshott, *M.A., M.D., F.R.C.P.* — FELLOW
National Hospital, Queen Square, London, W.C.1.

453. SLATER, Jack — MEMBER
5, Lochaline Street, London, W.6.

403. SLATER, Victor Wallace, *B.Sc., F.R.I.C., M.I.Chem.E.* — FELLOW
34, Montrose Avenue, Luton, Beds.

11. SLAZENGER, Ronald Chivas Gully, *B.A.* — FELLOW
1, Albemarle Street, W.1.

626. SMART, Alfred Athelstan, *F.R.A.S.* — MEMBER
2, Ferntower Road, London, N.5.

588. SMITH, Lt. Antony James Richard — FELLOW
"Roath," Old Winslade, Clyst St. Mary, Nr. Exeter, Devon.

175. SMITH, Donald R. — MEMBER
13, Church Road, Hartshill, Nuneaton, Warwicks.

28. SMITH, Edwin James — MEMBER
107, Mayfield Road, Hornsey, London, N.8.

367. SMITH, Frank, *A.F.R.Ae.S.* — FELLOW
18, Orchard Road, Farnborough, Hants.

3. SMITH, Ralph Andrew — FELLOW
19, Reith Road, High Wycombe, Bucks.

656. SMITH, Sidney John, *Grad.R.Ae.S.* — FELLOW
53, Ellerdine Road, Hounslow, Middx.

505. SNODGRASS, Richard B. — MEMBER
365, East McCreight Avenue, Springfield, Ohio, U.S.A.

717. SODEN, Andrew Lewis, *B.Sc., A.R.I.C.*, — MEMBER
44a, Lansdowne Road, Croydon, Surrey

214. SOUCHOTINSKY, Gustave — MEMBER
87, Avenue Jean Stobbaerts, Brussells, 3, Belgium.

510. SOUTO, Lt. Carlos Ernesto Martins — MEMBER
Departamento Maritimo, Lourenco Marques, Portuguese East Africa.

546. SPREADBURY, Richard S. — MEMBER
239, Blackfen Road, Sidcup, Kent.

712. STANTON, Henry K. B. — MEMBER
7, Lucas Avenue, Exeter, Devon.

253. STAPLEDON, Dr. Olaf — MEMBER
Simon's Field, Caldy, West Kirby, Wirral, Cheshire.

625. STEHLING, Kurt Richard, *B.A. (Toronto)* — FELLOW
65, Rogers Avenue, Buffalo, 11, N.Y., U.S.A.

543. STEPHEN, John Dunnett Lyon — MEMBER
10, Stockethill Crescent, Aberdeen.

75. STEPHENSON, Frederick Brian — MEMBER
208, Heath Road, Higher Bebington, Wirral, Cheshire.

73. STIFF, Robert S. — MEMBER
P.O. Box 69, Salem, Virginia, U.S.A.

197. STOCKS, George Raymond — MEMBER
Giant Gold Mines, Yellowknife, N.W.T., Canada.

657. STONE, Norman Sydney — MEMBER
134, Solihull Road, Shirley, Birmingham

732. STOTT, Ivor Raymond — MEMBER
3, New Mill, Smallbridge, Rochdale, Lancs.

22. STRONG, J. G., *B.Sc., A.C.G.I., A.F.R.Ae.S.* — FELLOW
7, Selwyn Drive, Hatfield, Herts.

636. STUBBINGS, Adrian Charles — MEMBER
6, The Terrace, H.M. Dockyard, Chatham, Kent.

607. SUNLEY, Henry Lambert Garbutt, *Grad.R.Ae.S.* — FELLOW
Woodfield, Fittleworth, Sussex.

37. SWIFT, Reginald David — MEMBER
152, Marrowbrook Lane, Cove, Farnborough, Hants.

586. SYKES, Egerton — MEMBER
9, Markham Square, London, S.W.3.

93. SYKES, Leslie — MEMBER
16, Circular Road, Denton, Lancs.

215. SYRATT, Brian Edwin, *B.Eng., G.I.E.E.* — FELLOW
F.O.R.D.E., Ivy Farm, Knockholt, Sevenoaks, Kent.

T

204. TABANERA, Teofilo — MEMBER
Tucuman 950, Buenos Aires, Argentine, S. America.

211. TANNER, John Charles — MEMBER
3, Hill Rise, Rickmansworth, Herts.

503. TARR, Graham Charles — MEMBER
17, Kingsfield Road, Watford, Herts.

138. TAYLOR, Frederick Burgess — MEMBER
"Quarmby," Lisson Grove, Hale, Cheshire.

120. TEMPLE, William F. — MEMBER
7, Elm Road, Wembley, Middx.

627. THACKRAY, Malcolm — MEMBER
"Hazelwood," Newlay Wood Avenue, Horsforth, Nr. Leeds.

389. THOMAS, Frederick Metcalf, *A.F.R.Ae.S.* — FELLOW
"Sea-Holme," Taunton Terrace, Avondale, Nr. Auckland, New Zealand.

160 THOMPSON, Gordon Vallins Elliot, *B.Sc., A.R.C.S., F.C.S.* — FELLOW
31, Brooklands Gardens, Gidea Park, Romford, Essex.

36. THOMPSON, Leonard Napier, *B.Sc., Grad.I.Mech.E.* — MEMBER
5, Letchwell Cottages, Forest Hall, Newcastle-on-Tyne, Northumberland.

563. THORILDSSON, Sigvard Olaf Thorild — MEMBER
3 dje Langgatan 27, Gothenburg, Sweden.

519. THORNTON, Alwyne Edward, *B.Sc.* — FELLOW
40, Maudslay Road, Coventry, Warwicks.

133. TIDMAN, Derek Albert — MEMBER
24, Kingsley Road, Palmers Green, N.13.

671. TIES, Sidney — MEMBER
5, Ash Grove, Guildford, Surrey

322. TIMBERLAKE, Alfred Phillip — MEMBER
46, West Grove, Rhostyllen, Wrexham, Denbighs.

222. TOPHAM, Eric — FELLOW
c/o 3, Forester Avenue, Bathwick, Bath, Somerset.

94. TOWNLEY, Wallace Kinnon Charles, *Grad.I.Mech.E.* — FELLOW
Broadgate Foot House, Middleton Road, Morecambe and Heysham, Lancs.

499. TREGURTHA, Kenneth Downing — FELLOW
"Tremar," Underhill Road, Stoke, Plymouth, Devon.

531. TRENCHARD, Percy — MEMBER
Lytchett, Ravons Road, Shoreham, Sussex.

109. TRILLE, William George — MEMBER
26, Queen's Road, Southall, Middx.

190. TURNER, Charles Teesdale — MEMBER
65, Station Road, Sidcup, Kent.

631. TURNER, John Richard — MEMBER
42, Selbourne Avenue, New Haw, Nr. Weybridge, Surrey.

162. TURNER, Miss Wendy E. S. — MEMBER
12, Budleigh Crescent, Welling, Kent.

430. TURNPENNY, Brian — MEMBER
14, Front Lane, Cranham, Upminster, Essex.

412. TYES, Sidney, *Grad.R.Ae.S.* — FELLOW
71, Southborough Road, London, E.9.

U

143. ULLMAN, John Talbot — MEMBER
374, Kingston Road, Ewell, Surrey.

45. UNITT, Kenneth Edward Thomas — MEMBER
67, The Mount, Cheylesmore, Coventry, Warwicks.

605. URRY, Norman — MEMBER
28, Reginald Road, Crosby, Scunthorpe, Lincs.

481. UYTENBOGAART, Professor Johannes W. H. — FELLOW
Bloemcamplaan 34, Wassenaar, Holland.

V

110. VENN, Joseph — FELLOW
77, Styvechale Avenue, Coventry, Warwicks.

393. VERHORST, Richard — MEMBER
Beukelsweg 87b, Rotterdam-W, Holland.

161. VLYMEN, David van — MEMBER
3, Nèville's Court, Dollis Hill Lane, N.W.2.

W

164. WAINE, Eric Marshall — MEMBER
113, Erskine Road, Sutton, Surrey.

350. WALKER, Dudley Frank, *A.R.Ae.S.* — FELLOW
c/o 56, Craven Road, Newbury, Berks.

614. WALKER, Ronald, *Comp.R.Ae.S.* — MEMBER
6, West Halkin Street, London, S.W.1.

442. WALLACE, S./Ldr. Richard Bruce — MEMBER
General Delivery, Ottawa, Ont., Canada.

406. WALMSLEY, John Henry, *A.F.R.Ae.S.* — FELLOW
80, Pitts Lane, Woodley, Reading, Berks.

349. WALPORT, Samuel, *L.R.C.P., L.R.C.S., L.R.F.P.S.* — MEMBER
248, Kilmarnock Road, Newlands, Glasgow, S3, Lanarks.

292. WALTERS, E. — MEMBER
"Portland Place," Vauxhall Street, Norwich, Norfolk.

611. WALTON, Peter Anderson — MEMBER
"Arosa," Rumsam Road, Barnstaple, N. Devon.

583. WATSON, Henry Augustine — MEMBER
24, Walnut Avenue, Alvaston, Derby.

451. WATSON, John Douglas — MEMBER
c/o Lloyds Bank, Ltd., 6, Pall Mall, London, S.W.1.

46. WATT, George Christie, *M.A.* — FELLOW
10, Albert Terrace, Aberdeen.

155. WATTS, Joseph — MEMBER
45, Crescent Road, Southport, Lancs.

121. WEBB, Ronald E., *B.Sc., A.C.G.I.* — FELLOW
10, Mount Harry Road, Sevenoaks, Kent.

287. WEBSTER, Douglas, *M.A.* — MEMBER
"Idlewild," Fountainhall Road, Aberdeen.

713. WEEDALL, Percy Norman — MEMBER
20, Palmerston Drive, Liverpool, 21, Lancs.

678. WEINER, Guy — MEMBER
151, Evering Road, London, N.16.

662. WELLS, Bernard James — MEMBER
26, Annandale Avenue, Bognor Regis, Sussex.

640. WESTFIELD, Alec — MEMBER
31, High Santon Villas, Appleby, Scunthorpe, Lincs.

681. WESTON, William — FELLOW
34, Mimosa Street, S.W.6.

698. WHATMORE, Bernard Frank — MEMBER
73, Boughton Lane, Loose, Maidstone, Kent.

165. WHITE, Hugh Stanley — MEMBER
Box 563, Kenya Advertising Corporation, Shell House, Nairobi, Kenya, E. Africa.

758. WHITE, Reginald Graham, *M.B., B.S.* — MEMBER
P.O. Box 84, Rusapi, Southern Rhodesia, Africa.

151. WHOLEY, Max W., *A.M.I.Mech.E.* — FELLOW
Tarbay Lane, Oakley Green, Nr. Windsor, Berks.

696. WICKS, Harold David — MEMBER
60, Melbury Court, London, W.8.

323. WILCOX, Arthur, *B.Sc.* — FELLOW
466, Stone Road, Lightwood, Stoke-on-Trent, Staffs.

255. WILKINS, Henry A. — MEMBER
85, Hangleton Road, Hove 4, Sussex.

769. WILKINS, James Humphre — MEMBER
26, Beacon Road, Loughborough, Lincs.

735. WILKINSON, Rex Stephen — MEMBER
28, Recreation Road, Tilehurst, Reading, Berks.

730. WILLIAMS, John Ames, *B.Sc.(Eng.), A.M.I.Mech.E.* — FELLOW
11, Moreton End Lane, Harpenden, Herts.

672. WILLIAMS, Peter Richard Geoffrey — MEMBER
Heyward, Westbury, Wilts.

567. WILLIAMS, Ronald Sidney — MEMBER
32, Ashbourne Road, Mitcham, Surrey.

217. WILLIAMS, Robert Wesley — MEMBER
73, Holmefield Road, Liverpool, 19, Lancs.

86. WILLIAMS, William Lloyd — MEMBER
22, Baabec Road, Highbury, N.5.

231. WILLIAMSON, R. — MEMBER
"Rothesay," West Road, Stoney Hill, Bromsgrove, Worcs.

613. WILLIS, Richard Hartley — MEMBER
908, West John Street, Champaign, Illinois, U.S.A.

72. WILSON, J. — MEMBER
"Arran," Nightingale Avenue, East Horsley, Surrey.

43. WILSON, Laurence, *M.A.* — MEMBER
3, Sheridan Road, Merton Park, London, S.W.19.

314. WINDSOR, Maurice William — MEMBER
106, Windmill Road, Gillingham, Kent.

492. WODHAMS, Basil Scott — MEMBER
13, Wallasey Crescent, Ickenham, Uxbridge, Middx.

571. WOODRUFF, Alan Ivor — MEMBER
111, Portland Avenue, Gravesend, Kent.

313. WOODTHORPE, John Malpas — MEMBER
20, Knights Hill, London, S.E.27.

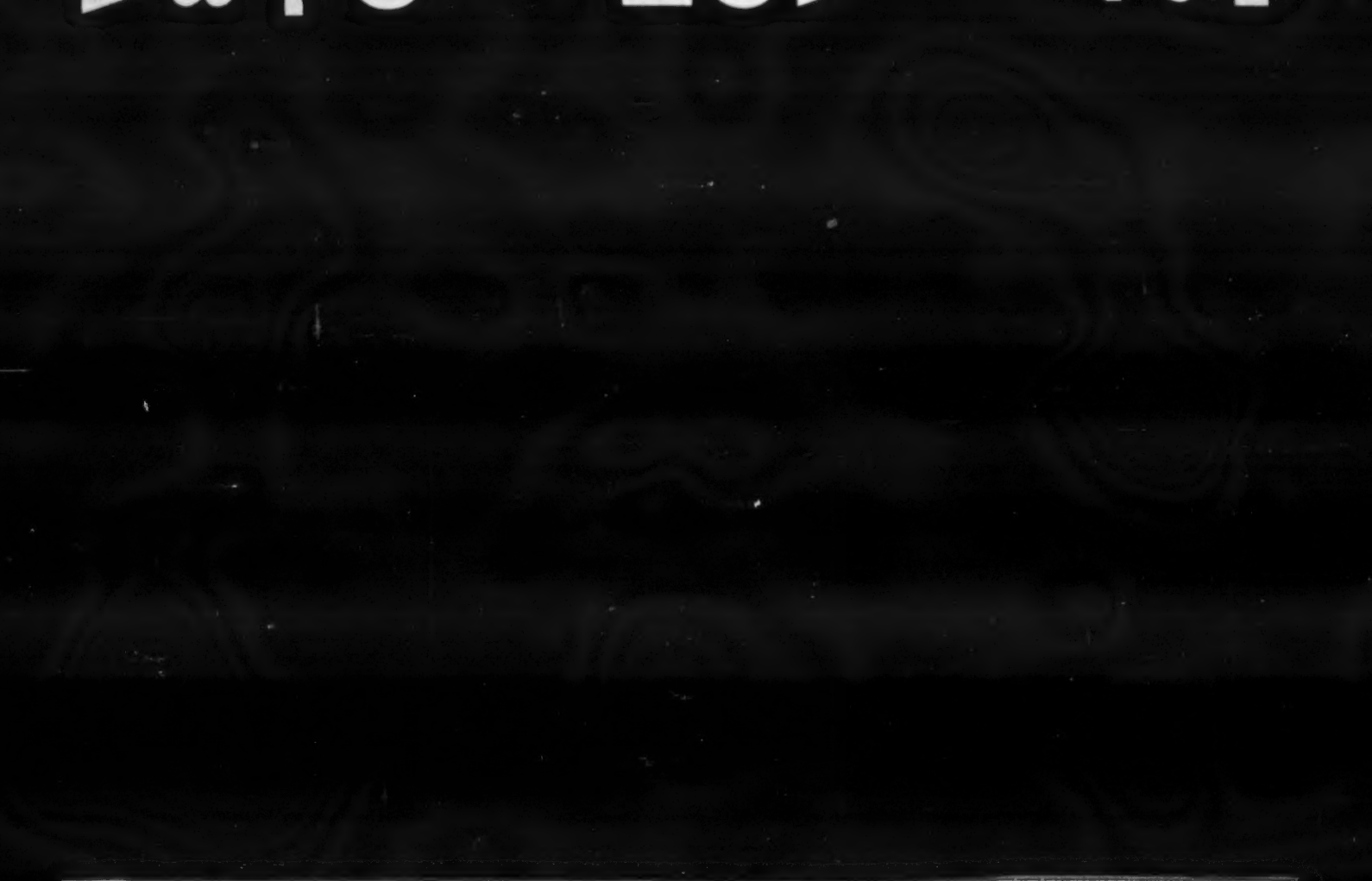
673. WRIGHT, Harry Anthony Grosvenor — MEMBER
80, Bristol Road, Edgbaston, Birmingham.

27. WRIGHT, Michael Stephen — MEMBER
Strawberry Cottage, Hebden Road, Haworth, Keighley.

Y

58. YATES, Peter, *B.Sc.* — MEMBER
2768, Yale Station, New Haven, Conn., U.S.A.

221. YOUNG, Thomas Gregson — MEMBER
23, Queen Street, Great Harwood, Blackburn, Lancs.

Z

542. ZUMPE, Herman Frank — FELLOW
R.A.E., Wescott, Nr. Aylesbury, Bucks.